CORNELL UNIVERSITY | Sloan-Kettering Institute

WEILL GRADUATE SCHOOL *of* MEDICAL SCIENCES *of* CORNELL UNIVERSITY

2005–2007 Catalog

Our School

Our goal is to provide a supportive environment that allows our students to freely pursue the study of science.

Our Faculty

Our world-renowned staff is focused on helping students achieve their goals through the study of science.

Our Students

Our students are our colleagues and collaborators—an essential part of our academic and social community.

Academic Calendar 2005-2006

2005

Orientation for new students	Monday, August 29 – Friday, September 2
Quarter I Registration	Monday, August 29 – Friday, September 2
Labor Day Holiday	Monday, September 5
Quarter I begins	Tuesday, September 6
Quarter I Deadline for course withdrawal	Friday, September 30
Quarter I ends	Friday, November 11
Quarter I Examinations	Monday, November 14 – Friday, November 18
Quarter II Registration	Monday, November 14 – Friday, November 18
Thanksgiving recess	Thursday, November 24, Friday, November 25
Quarter II begins	Monday, November 28
Quarter II Deadline for course withdrawal	Friday, January 6
Winter Recess	Thursday, December 22 – Friday, December 30
New Year's Day Observed	Monday, January 2

2006

Classes resume 9:00 a.m.	Tuesday, January 3
January degree thesis submission deadline	Friday, January 6
Martin Luther King Day holiday	Monday, January 16
Conferral of January degrees	Wednesday, January 18
Quarter II ends	Friday, February 3
Quarter II Examinations	Monday, February 6 – Friday, February 10
Quarter III Registration	Monday, February 6 – Friday, February 10
Recruitment Weekend	Wednesday, February 22 – Saturday, February 25
Quarter III begins	Monday, February 13
Presidents' Day holiday	Monday, February 20
Quarter III Deadline for course withdrawal	Friday, March 17
Quarter III ends	Friday, April 14
Quarter III Examinations	Monday, April 17 – Friday, April 21
Quarter IV Registration	Monday, April 17 – Friday, April 21
Spring Break	Monday, April 24 – Friday, April 28
Quarter IV begins	Monday, May 1
26th Annual Vincent du Vigneaud Memorial Research Symposium; no classes	Tuesday, May 2
Deadline for May degree thesis submission	Friday, May 5
Convocation Ceremony	Wednesday, May 17
Commencement Exercises	Thursday, May 18
Quarter IV Deadline for course withdrawal	Friday, May 19
Memorial Day holiday	Monday, May 29
Quarter IV ends	Friday, June 30
Independence Day holiday	Tuesday, July 4
Summer Research Term Begins	Wednesday, July 5 – Friday, July 7
Summer Research Term Registration	Wednesday, July 5 – Friday, July 7
Quarter IV Examinations	Wednesday, July 5 – Friday, July 7
Deadline for August Degree Thesis Submission	Friday, August 4
Conferral of August degrees	Monday, August 21
Summer Research Term ends	Friday, August 25

Note: Courses are taught on a quarterly basis. Degrees are conferred in January, May and August.
Calendar dates are subject to change at any time by official action of Weill Graduate School of Medical Sciences of Cornell University.

WEILL GRADUATE SCHOOL *of* MEDICAL SCIENCES *of* CORNELL UNIVERSITY

This catalog presents the faculty and programs of study of the Weill Graduate School of Medical Sciences of Cornell University.

If we define biomedical science as the pursuit of knowledge in areas of fundamental biology relevant to human health and disease, then the unique resources of our school can indeed provide a superb training opportunity for those interested in the medical sciences. Medicine and biology are in the midst of an unprecedented revolution that is unraveling the molecular mechanisms governing basic biological processes such as gene replication, intracellular signaling, trafficking of lipid and proteins, neuronal communication, host-defense mechanisms, protein folding and embryonic development, to name a few. From these insights, new strategies and technologies for addressing the diagnosis and therapy of disease have evolved. Our seven PhD graduate programs offer unique research and educational opportunities for you to master the scientific method of conducting investigative research. We believe that the training opportunities supported by NIH training and research grants will also open the doors to rewarding careers in many fields of professional activity, including academia, industry, government and health affairs.

The Weill Graduate School of Medical Sciences is located in New York City on Manhattan's Upper East Side and is part of a complex of adjoining world-renowned institutions dedicated to excellence in biomedical research. The school provides modern and affordable residences in this safe and exciting section of the city.

Training toward the PhD, MS and combined MD-PhD degrees is offered by faculty drawn from Weill Cornell Medical College and Sloan-Kettering Institute. With a roster of 220 outstanding faculty members and 317 students, the school offers a faculty-to-student ratio that ensures a close and productive working relationship between each student and his or her faculty mentor. We invite you to examine the programs defined here. We would be happy to receive your application for admission, should you decide that your own scientific interests and preparation match the graduate training offered by our institution.

David P. Hajjar

David P. Hajjar, PhD
Vice Provost and Dean

The Graduate School was founded on the powerful notion that the convergence of two great institutions could offer an extraordinary training ground for future generations of biomedical researchers. Fifty years and more than 1,000 alumni later, Weill Cornell has emerged as one of the premier graduate schools in the country.

Table of Contents

4 About Our School

4 Who We Are
4 Where We're Located
5 Programs of Study
5 Campus Libraries
5 Student Training
6 Training Grant Support

8 General Information

8 Application for Admission
10 Campus Life
11 Housing
11 On-Campus Activities
11 Health Care

12 Financial Information

12 Stipend, Tuition and Fees
12 Financial Assistance
12 Scholarships and Fellowships
13 Awards and Prizes

14 Degree Requirements

14 The Special Committee
14 Registration and Course Grades
15 Residence
15 Study in Absentia
15 Leave of Absence
15 Examinations
15 Thesis
15 Candidate for Degree Only

16 Programs of Study

17 Biochemistry and Structural Biology
21 Cell Biology and Genetics
25 Immunology and Microbial Pathogenesis
29 Molecular Biology
33 Neuroscience
39 Pharmacology
43 Physiology, Biophysics and Systems Biology
47 Clinical Epidemiology and Health Services Research
50 Additional Areas of Concentration

51 Course Offerings

51 Allied Programs: Biochemistry and Structural Biology, Cell Biology and Genetics, and Microbiology Programs
54 Immunology and Microbial Pathogenesis Program
54 Neuroscience Program
55 Pharmacology Program
57 Physiology, Biophysics and Systems Biology Program

59 Outreach Programs

59 Cornell University Intercampus Student Exchange
59 ACCESS Summer Internship Program
60 Teaching Opportunities
60 Middle School and High School Outreach
60 Cornell Science Challenge

61 Administration

62 Faculty

About Weill Graduate School of Medical Sciences of Cornell University

Who We Are

The Joan and Sanford I. Weill Graduate School of Medical Sciences of Cornell University was founded on the premise that the convergence of two great institutions, the Joan and Sanford I. Weill Medical College of Cornell University and the Sloan-Kettering Institute, could offer exceptional training for future generations of biomedical researchers. In 1952 professional staff of these two major medical institutions were brought together, and this unique academic partnership was formalized under the auspices of the Graduate School of Cornell University. Now, more than 50 years and 1,000 alumni later, the Weill Graduate School of Medical Sciences has emerged as a premier institution of biomedical research. Our programs offer a well-integrated teaching staff whose research interests span the full spectrum of biomedical science, and a collaborative environment where faculty and students thrive.

Where We're Located

The Weill Graduate School of Medical Sciences is part of a large biomedical center extending along York Avenue between 66th and 71st streets on Manhattan's Upper East Side. The center's institutions are all committed to research training and patient care and include the Weill Medical College of Cornell University, Memorial Sloan-Kettering Cancer Center, New York-Presbyterian Hospital, the Hospital for Special Surgery and The Rockefeller University. The great majority of the research laboratories of the Weill Graduate School faculty as well as other academic core facilities are located within the Weill Cornell Medical College and Sloan-Kettering Institute. In addition, what Dr. Carl Nathan calls "the necklace of pharmaceutical industries that surrounds the city," extending from upstate New York through New Jersey, provides students with tremendous professional opportunities.

Programs of Study

PhD Programs

The Weill Graduate School of Medical Sciences offers a variety of training opportunities in the biomedical sciences. Over 220 faculty members with common interests in graduate education and basic biological and biomedical scientific research are appointed to the Graduate School faculty in a particular program of study. The Weill Graduate School offers PhD degrees in seven programs of study:

- Biochemistry and Structural Biology
- Cell Biology and Genetics
- Immunology and Microbial Pathogenesis
- Molecular Biology
- Neuroscience
- Pharmacology
- Physiology, Biophysics and Systems Biology

Areas of Concentration

- Cancer Biology
- Chemical Biology
- Computational Biology
- Developmental Biology
- Microbiology

MS Program

The Weill Graduate School offers a master of science degree program in Clinical Epidemiology and Health Services Research to qualified physicians and nurses.

Campus Libraries

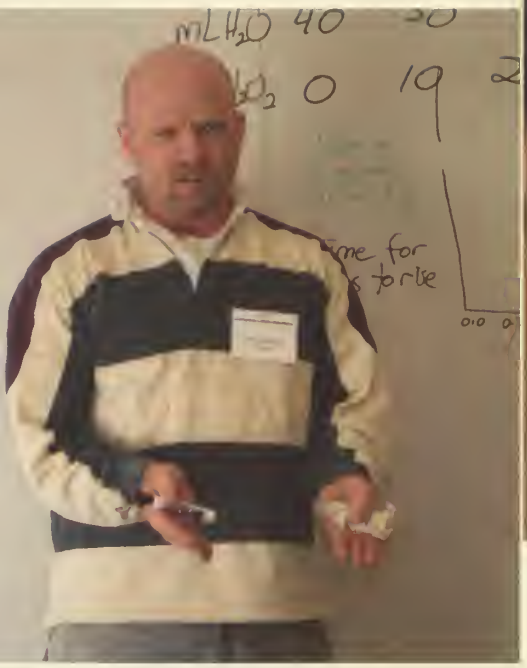
The Samuel J. Wood Library at Weill Medical College and the Nathan Cummings Center at Memorial Sloan-Kettering Cancer Center are the cornerstones of the information resources available to students on campus. The modern and comfortable Wood Library houses over 151,160 volumes and subscribes to 1,424 journals. As one of the country's first fully automated medical libraries, it features computer terminals that provide access to the library's collections from any of several-hundred networked desktop computers and student workstations throughout the Weill Graduate School. Every student has an e-mail account and electronic access to all scientific journals. Adding to the accessibility of up-to-the-minute information, the libraries share databases with the Hospital for Special Surgery and The Rockefeller University.

Student Training

Entering students take a series of intensive required courses in a chosen program of study. The courses provide a fundamental understanding of the discipline and an introduction to research. First-year students also participate in 12-week rotations in faculty laboratories. Conducting research in a variety of disciplines aids students' project selection. The rotations also expose students to the intellectual breadth and depth of faculty research and illustrate the ways in which sophisticated state-of-the art methodologies are contributing to the field.

Students present their work from their experimental laboratory research to other students and faculty at program seminars, retreats and the annual Vincent du Vigneaud Memorial Research Symposium. Students are also encouraged to present at national and international conferences and to publish their findings in professional journals. Prior to graduation, making their mark on biomedical research before they even leave school, a significant number of students publish their findings in front-rank professional journals, often with first author status.

The faculty of the Weill Graduate School is committed to providing the best possible research experiences for all students. "We're focused on maintaining high standards," reports Dr. Ken Marians. "What makes this such a great institution is that we attract high-quality faculty interested in interacting with students, and we provide an infrastructure that allows people to do cutting-edge research in their field."



Training Grant Support

A number of WGSMS graduate students are supported by institutional training grants from funding agencies such as the National Institutes of Health (NIH), the Lucille P. Markey Charitable Trust, and the Cancer Research Institute. Training grants provide funds for student stipends and laboratory supplies. The following chart outlines the eight training grants available at WGSMS. Graduate students placed on the training grants are selected by faculty committee.

Program	Director	Funding Agency
Immunology Research Training Grant	William A. Muller, MD, PhD	National Institutes of Health
Cancer Pharmacology Training Grant	Lorraine J. Gudas, PhD	National Cancer Institute
Vascular Biochemistry and Atherosclerosis Training Grant	David P. Hajjar, PhD	National Heart, Lung, and Blood Institute
Pharmacology and Neuroscience of Drug Abuse Training Grant	Charles E. Inturrisi, PhD	National Institute on Drug Abuse
Tri-Institutional Training Program in Vision Research	Enriqué Rodriguez-Boulan, MD, PhD	National Eye Institute
Training Program in Molecular and Cellular and Developmental Biology	Marilyn D. Resh, PhD	National Institute of General Medical Sciences
Molecular Mechanisms of Neurological Disease Training Grant	John A. Wagner, PhD	National Institute of Neurological Disorders and Stroke
Pre-Doctoral Fellowship Program in Tumor Immunology	Carl F. Nathan, MD, PhD	Cancer Research Institute

MICHAEL JACKSON
IN STORE OCT. 30
warm. witty. welcoming. wired.
Imagine all the people living life in peace.
TO THE POWER OF MAXELL
maxell
RENTING IS BETTER THAN BUYING.
DINNER FOR FIVE
FEET UNDER
JORDACHE
organ Stanle
THE ORIGINAL GEORGE W.
WATCH AND JEWELRY OUTLET
URINETOWN

General Information

Application for Admission

Applications to the Weill Graduate School of Medical Sciences of Cornell University are accepted for the degree of Doctor of Philosophy and, in the case of the Clinical Epidemiology and Health Services Research program, for the degree of Master of Science.

Prerequisites

An applicant must: (1) have a baccalaureate degree or equivalent from a college or university of recognized standing, (2) have adequate preparation in the chosen field of study and (3) show promise of ability to pursue advanced study and research, as judged by his or her previous record.

Programs of Study

Students are admitted to one of the following PhD programs:

- Biochemistry and Structural Biology
- Cell Biology and Genetics
- Immunology and Microbial Pathogenesis
- Molecular Biology
- Neuroscience
- Pharmacology
- Physiology, Biophysics and Systems Biology

or to the following MS program:

- Clinical Epidemiology and Health Services Research

Doctoral students apply to the Program of Study of their choice. However, the initial affiliation with a program is far from rigid. A student, after developing an awareness of the variety of research projects available for training, may remain in the original program or change. Program transfers usually occur during the first year of graduate study so that the student may complete the required coursework for his or her new program before taking the Admission to Doctoral Candidacy Examination, which is held at the end of the second academic year.

Getting an Application

Applicants are encouraged to apply online. To apply online or to download an application, visit our Web site at http://biomedsci.cornell.edu/. Admissions Coordinator, Weill Graduate School of Medical Sciences of Cornell University, 445 East 69th Street, Suite 412; New York, NY 10021. You may also request an application from: tel: 212-746-6565; fax: 212-746-8906; e-mail: gsms@med.cornell.edu.

The following materials must accompany the completed application form:

1. Official transcripts of records from all colleges and universities attended.
2. A statement of purpose of graduate study.
3. Two letters of recommendation from individuals in academic positions who know the applicant professionally.
4. The applicant's scores from the Graduate Record Examinations (GRE). Application for taking the Aptitude (Verbal, Quantitative and Analytical Writing) Test must be made directly to the Educational Testing Service, Graduate Record Examinations, P.O. Box 6000, Princeton, NJ 08541-6000. International students whose native language is not English are required to take the Test of English as a Foreign Language (TOEFL) examination. Application for this test must be made to Test of English as a Foreign Language, P.O. Box 6151, Princeton, NJ 08541-6151. The proper Institution Code Number to use in the GRE or TOEFL application for the Weill Graduate School of Medical Sciences of Cornell University is R 2119.

All applications and credentials must be postmarked by the deadline date of December 1. A nonrefundable application fee of $60 must accompany the application for admission. For early applications postmarked by November 15, a reduced nonrefundable fee of $40 must accompany the application.

The Admissions Process

The completed application and all supporting documents are initially screened by the credentials committee for the Programs of Study to which the student is applying. Applicants considered potentially acceptable will be notified and invited to attend the Graduate School recruitment days that are held in February. These two days consist of program orientation, personal interviews, meeting fellow candidates, current graduate students and faculty and visiting New York City, all in a relaxed atmosphere. The applications of candidates approved by each program are forwarded to the dean for final decision. Students accepted for study in the Weill Graduate School of Medical Sciences of Cornell University are formally notified by a letter from the dean. The Weill Graduate School requests that applicants accepted for admission inform the school promptly of their intention to either accept or reject the offer of admission. The final date for acceptance is April 15.

It is the policy of Cornell University to actively support equality in educational and employment opportunities. No person shall be denied admission to any educational program or activity or be denied employment on the basis of any legally prohibited discrimination involving, but not limited to, such factors as race, color, creed, religion, national or ethnic origin, sex, age or handicap. Admission policies are also in conformity with policies of New York State with regard to the American ideal of equality of opportunity as embodied in the Education Practices Act.

Campus Life

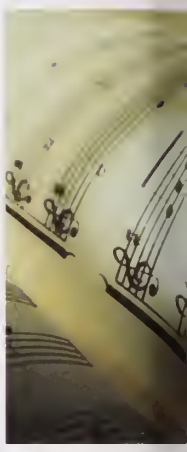
New York City offers the best of many worlds, and opportunities abound to invigorate your senses and stimulate and satisfy your intellect. Enjoy lectures from world-renowned scientists, visit museums and galleries, see Broadway shows, and attend concerts.

New York's Biomedical Resources

Research in New York City is enormously diverse and dynamic. The metropolitan area is home to 25 major academic research and medical centers and nearly 200 hospitals, research centers and laboratories. New York City receives a larger portion of NIH funding than any other city in the United States, and our researchers and institutions hold the highest number of biotechnology-related patents in the country. This is not surprising, since the highest number of PhDs in biological sciences are awarded to students graduating from New York City schools, and nearly one in four New Yorkers has a graduate or professional degree.

New York's Leisure-Time Diversions

Student life is augmented dramatically by being located within one of the world's great cities, so soon after Weill Graduate School students arrive on campus, they are taken on a tour as part of their orientation program. New York City offers an unmatched range of cultural and recreational activities, many within walking distance of the campus and all readily accessible by public transport. Much of the world's best art, music, theater, ballet, cinema and cuisine is concentrated in Manhattan and is practically at the students' doorsteps. New York City's world-famous major museums are nearby: a sampling includes the Museum of Modern Art on 53rd Street, the Whitney Museum of American Art on nearby Madison Avenue and the Metropolitan Museum of Art and the Guggenheim Museum on Fifth Avenue. Across Central Park are the American Museum of Natural History, with its famous dinosaur exhibit, and the Lincoln Center for the Performing Arts, home of the Metropolitan Opera and the New York Philharmonic. Farther downtown is Carnegie Hall, renowned for its offerings of both classical music and jazz. On summer evenings, free concerts and opera are performed on the lawns of Central Park. An added bonus is that many of the cultural events, including Broadway plays, movies, operas and concerts, are made available by the school to graduate students to enjoy at affordable prices. For sports enthusiasts there is Madison Square Garden, home to the Knicks, the Liberty and the Rangers. Magnificent Central Park, the East River Promenade near Weill Cornell's campus and the Hudson River Promenade near the World Financial Center are all perfect for strolling, biking, jogging and roller blading. Affordable admissions to health clubs, including swimming pools, are available. Students also have access to a gymnasium at Olin Hall.



Free noontime music recitals, featuring fine soloists and groups, are held on Fridays on the adjacent Rockefeller University campus. During the warmer months, street fairs are held in various neighborhoods of the city. Numerous international restaurants and first-run cinemas provide nourishment and entertainment for every taste.

Those inclined to roam a short distance beyond New York City's boundaries can participate in student-organized hiking or skiing trips to the mountains north of the city. Long Island's beautiful beaches are also within easy reach. New York City is an unparalleled place to learn and to do science. Further excitement and enrichment are in store for the student who wishes to experience this great city.

Housing

Students live within a few blocks of classrooms and laboratories, on a self-contained campus that is part of a safe residential neighborhood on the prestigious Upper East Side of Manhattan. The many shops and restaurants in the immediate vicinity, including markets and delis for convenient food shopping, lend this neighborhood the aura of a small, well-defined community.

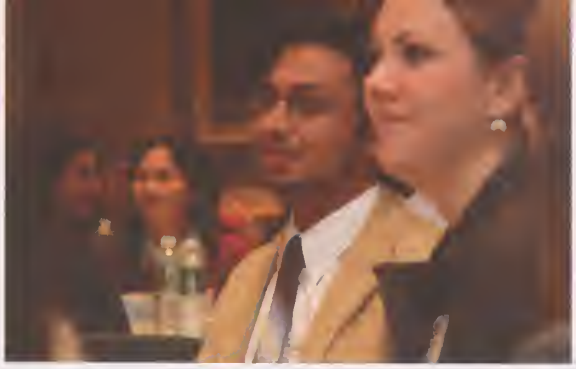
Apartment housing is offered to all full-time students for the PhD training period. Rents paid by students are lower than those charged for comparable nonstudent housing in the neighborhood. Four housing complexes are available:

Sloan House, located at 1233 York Avenue, between 66th and 67th streets, contains studio and one-bedroom apartments that are available only to graduate students. All apartments are air-conditioned and fully furnished and have balconies. Building amenities include laundry facilities, front-door security, a new lounge for social relaxation in a quiet, upscale setting and easy access to graduate faculty laboratories at Weill Medical College and the Sloan-Kettering Institute. Pets are allowed subject to housing restrictions.

Lasdon House, an apartment residence located at 420 East 70th Street, between York and First avenues, contains studio, one-bedroom and two-bedroom apartments for graduate students. Apartments are fully furnished and air-conditioned. Building amenities include laundry facilities, front-door security, a recreation room and an outdoor terrace. These apartments are available as roommate shares or family housing only. Pets are not permitted.

303 East 71st Street, an apartment building located between First and Second avenues, contains studio, one- and two-bedroom furnished apartments. Pets are allowed subject to housing restrictions.

Livingston-Farrand Apartments, located on East 69th Street between York and First avenues, features furnished, economical studio, one-bedroom and two-bedroom apartments with kitchen facilities. These apartments are available for upper-class medical and graduate students who desire single-occupancy accommodations. Pets are not permitted.



On-Campus Activities

Student and Faculty Club

The Student and Faculty Club provides a relaxed and casual gathering place for Graduate School faculty and students. The hours are Monday through Thursday, from 12:00 noon to 9:30 p.m., and from 12:00 noon to 11:00 p.m. on Fridays. The club is located on the ground floor of the Sloan House building, and entrance is through the lobby of the Rockefeller Research Laboratories at 430 East 67th Street. Amenities include coffee, tea and pastry service; a full-service bar; a large-screen TV; and a pool table on the mezzanine level. Every Friday evening graduate students can convene in the club for a social hour. Refreshments are provided and all are welcome.

Student Government

The Weill Graduate School's Graduate Student Executive Council (GSEC) offers students the opportunity to participate in and make recommendations to the school's administration. The Student Executive Council also organizes many events throughout the year and is highly influential in defining the student needs that are to be brought to the Associate Dean and Graduate School Executive Committee for action.

Health Care

The Weill Graduate School of Medical Sciences is dedicated to providing the finest medical care to students. Prior to matriculation, students must have their personal physician perform a general health examination, which must include a physical examination, a chest x-ray and basic laboratory tests. The results must be forwarded to Student Health Services.
All full-time students enrolled in one of the PhD degree–granting programs are covered by a comprehensive health plan. This includes access to Student Health Services, New York-Presbyterian Hospital clinics and physician referrals. Major-medical coverage for students is available

Financial Information

Stipend, Tuition and Fees

PhD Program

- All students accepted to PhD degree–granting programs are awarded a full tuition scholarship, which includes all tuition and health-insurance costs.
- In addition to a full tuition scholarship, a generous graduate-student stipend of $28,989.00 a year is awarded to each full-time student.

Master's Degree Program

Tuition for a full-time student matriculated in the Clinical Epidemiology and Health Services Research master's degree program is $21,000 for the entire program. However, students may matriculate and pay tuition on a per-credit-hour basis, currently $700 a credit hour. Tuition includes fees for matriculation and graduation, as well as miscellaneous thesis expenses.

Financial Assistance

Students who wish to apply for a Stafford Student Loan or other federal assistance are required to submit a Free Application for Federal Student Aid (FAFSA) for an estimate of financial need. Application forms can be obtained from the Graduate School Office.

Limited financial assistance for qualified applicants is available in the form of a student loan from the Weill Graduate School to qualified applicants.

Scholarships and Fellowships

The Fellowships Office, directed by Dr. Brian Turner, WGSMS '02, was established to aid graduate students in the selection, writing and submission of predoctoral fellowship applications. Students are encouraged to apply for competitive predoctoral fellowships available from sources such as the National Science Foundation, the National Research Council, and the Howard Hughes Medical Institute. Information about these fellowships may be obtained directly from the Graduate School Office. In addition, the office also helps administer 8 institutional training grants and 20 graduate student scholarships that support approximately 70 WGSMS students.

Although WGSMS guarantees full funding, graduate students are strongly encouraged to apply for external funding. Predoctoral fellowships offer both money and prestige, since a fellowship recipient receives a full stipend and a yearly cash award provided by WGSMS.

The Fellowships Office handles all clerical and administrative aspects of applications. For example, the office (1) suggests appropriate fellowships and advises students in the application process, (2) assists with collection of biographical and background information, (3) completes all administrative paperwork and (4) handles the financial expenses incurred throughout the application process. The student's primary responsibility is to develop a research proposal in collaboration with his or her Program Director and mentor.

Prestigious Predoctoral Fellowships for Students in Biomedical Science

The following list of predoctoral fellowships gives a few examples of potential graduate-student funding sources.

Department of Defense
http://www.asee.org/ndseg

Ford Foundation Predoctoral Fellowship for Minorities
http://www7.nationalacademies.org/fellowships/

NIH Predoctoral Fellowship Awards for Minority Students
http://grants.nih.gov/grants/guide/pa-files/PA-00-069.html

NSF Graduate Research Fellowships
http://www.orau.org/nsf/nsffel.htm

Paul and Daisy Soros Fellowships for New Americans
http://www.pdsoros.org

WGSMS-Administered Graduate Student Fellowships

WGSMS awards select students with full fellowships. A faculty committee chooses the recipients of these fellowships. Recipients become PhD fellows and are awarded full tuition scholarships and stipend support. There is no student application process. The complete list of WGSMS-administered fellowships are listed below.

The Frank L. Horsfall, Jr., Fellowships
The Shirley L. Marshak Fellowship
The Jacques Cohenca Predoctoral Fellowship
The Margaret and Herman Sokol Predoctoral Fellowship
The Scottish Rite Schizophrenia Research Fellowship

Awards and Prizes

The Julian R. Rachele Prize was established in memory of Dr. Julian R. Rachele, former dean of the Weill Graduate School of Medical Sciences, and awards an annual prize of $1,500 for the best research paper published during the year by a PhD candidate.

The Vincent du Vigneaud Prizes ($1,000) Awards of Excellence ($750) and First Year Awards ($500), are given for the presentation of outstanding papers by students of the Weill Graduate School of Medical Sciences at the Annual Vincent du Vigneaud Memorial Research Symposium.

Degree Requirements

The Special Committee

In programs leading to the PhD degree, the Special Committee is regarded as the agent primarily responsible for the candidate's development. The Special Committee is expected to act as a committee, under the leadership of the chairperson, for the purpose of developing the candidate's independence in scholarship. There are no regulations of the Weill Graduate School of Medical Sciences of Cornell University faculty governing the specific content of instruction, courses or grades to which the Special Committee must subscribe, except those established by the program. It is the prerogative of the Special Committee to impose any requirements which they deem educationally sound over and above the general requirements. A candidate selects the members of his or her Special Committee with the approval of the program director and the dean, with their consent, from the current roster of WGSMS faculty.

The Special Committee includes the candidate's major thesis advisor and two other faculty members selected by the student with the advice and consent of the major thesis advisor. They may represent one or several programs. Members of the Special Committee must be nominated by the student and approved by the dean or associate dean before the middle of the second year of residence in WGSMS. A temporary advisor in the student's Program of Study will be appointed during the first few weeks of residence to guide the student in the choice of laboratory rotations, courses and selection of a permanent thesis advisor.

Registration and Course Grades

At the beginning of each term, students are required to register with the Graduate School Office. All courses for which a student registers for credit will be entered in the official transcript record. Grades of graduate students are reported as: Honors (A equivalent), High Pass (B equivalent), Low Pass (C equivalent), Fail (F equivalent), Incomplete (I), Absent (Abs), Withdraw (W) or Audit (Aud). Registration for the summer term is required of graduate students who will be engaged in research.

Residence

WGSMS regards study in residence as essential. Each candidate for an advanced general degree is expected to complete the residence. A student must register each term from the time of initial registration in the Graduate School until the student either withdraws or completes a degree, unless a leave of absence has been granted. Students may register online. Full-time study for three academic years with satisfactory accomplishment are required for the doctoral degree. Currently, the average time to achieve the PhD is 5.5 years. No more than 7 years may intervene between the time of first registration and the completion of all requirements for the doctoral degree.

Study in Absentia

A candidate for a PhD may petition for permission to study away from Cornell University while regularly registered in WGSMS. The student's thesis research will continue to be directed by the Special Committee.

Leave of Absence

A candidate who finds it necessary to interrupt the continuity of his or her residence must petition the associate dean for an official leave of absence. This written petition must specify the term of absence, state the reason for the requested leave of absence and be approved by the student's major sponsor.

Examinations

Examinations required by WGSMS include:

(1) examination for Admission to Doctoral Candidacy,

(2) final examination for the MS degree in Clinical Epidemiology and Health Services Research or

(3) final examination for the PhD degree.

Examinations are administered by an examining committee consisting of a chairperson and members of the Graduate School faculty. The Admission to Doctoral Candidacy Examination is administered independently by each program. In addition to these examinations, the program may require a qualifying examination as part of its evaluation of the candidate after one year of residence has been completed.

The Admission to Doctoral Candidacy Examination is both oral and written and certifies that the student is eligible to work toward a thesis in the Graduate School of Medical Sciences. The examination must be taken before the end of the second year of residence.

Thesis

A principal requirement for both the MS in Clinical Epidemiology and Health Services Research, and the PhD degrees is the presentation of a thesis constituting an original contribution to the body of scientific research. Ordinarily, the thesis is written on a research topic in the candidate's major field of study, under the direction of the special committee. The time between the thesis defense and submission of the thesis in its final form is limited to 60 days. The PhD thesis will be published in abstract and recorded electronically. The final examination for the PhD degree is an oral defense of the candidate's thesis. It must be passed within seven years of the date of first registration.

Candidate for Degree Only

A graduate student who has fulfilled all degree requirements, with the exception of the final thesis submission, and is no longer a full-time student, is granted Candidate for Degree Only status, which remains in effect until graduation. Degree conferral takes place three times a year; January, May and August, with the May commencement held jointly with MD degree graduates of Weill Medical College of Cornell University.

Programs of Study

Biochemistry and Structural Biology

The Biochemistry and Structural Biology Program offers opportunities to develop research training in the areas of molecular structure determination, molecular mechanism of membrane trafficking, protein folding, signal transduction, mechanisms, gene structure and nucleic acid chemistry. The Biochemistry and Structural Biology Program is a member of an Alliance of three Programs that includes Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology.

Cell Biology and Genetics

The Cell Biology and Genetics Program offers opportunities to develop research training in cell or developmental biology, genetics and molecular biology. The Cell Biology and Genetics Program is a member of an Alliance of three Programs that includes Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology.

Immunology and Microbial Pathogenesis

The Immunology Program brings together for research and teaching a diverse set of scientists who seek to understand how genes, cells and molecules fight infection, cancer and grafted cells, and how they misfire to cause autoimmune disease.

Molecular Biology

The Molecular Biology Program offers opportunities to develop research training in cell or developmental biology, genetics and molecular biology. The Molecular Biology Program is a member of an Alliance of three Programs that includes Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology.

Neuroscience

The Neuroscience Program studies the development, structure and function of the nervous system, using a wide variety of scientific disciplines, including molecular genetics, biochemistry, pharmacology, neuroanatomy, electrophysiology, molecular biology, computational neuroscience and behavior.

Pharmacology

The research activities of the Pharmacology Program are directed at understanding how drugs and chemicals modify biological systems.

Physiology, Biophysics and Systems Biology

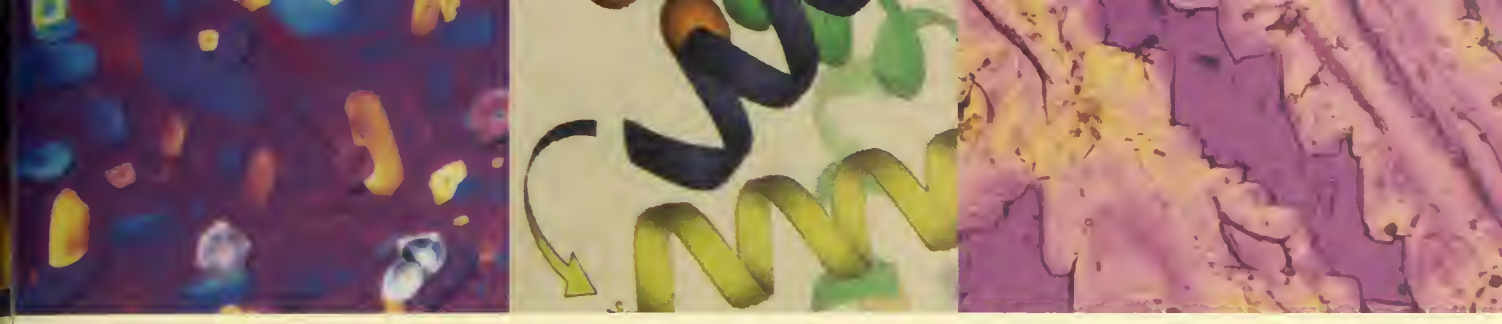
Research in physiology, biophysics and systems biology combines studies of function at the molecular and cellular levels with integration of this knowledge into analysis of organ systems and whole animals. A strong emphasis is placed on a quantitative understanding of each level of organization.

Clinical Epidemiology and Health Services Research

The Program of Study leading to the master of science (MS) degree in Clinical Epidemiology and Health Services Research is designed for health-care professionals who wish to plan, implement and analyze quantitative and qualitative research studies, using appropriate research designs.

Additional Areas of Concentration

Cancer Biology, Chemical Biology, Computational Biology, Developmental Biology and Microbiology.



Biochemistry and Structural Biology

Faculty

Olaf S. Andersen, MD
Francis Barany, PhD
Esther M. Breslow, PhD
David Eliezer, PhD
Jonathan Goldberg, PhD
Steven Gross, PhD
David P. Hajjar, PhD
Jerard Hurwitz, PhD
Scott Keeney, PhD
Thomas J. Kelly, MD, PhD
Richard N. Kolesnick, MD
Amy Lam, PhD
Christopher D. Lima, PhD
Min Lu, PhD
Kenneth J. Marians, PhD
Frederick R. Maxfield, PhD
Timothy E. McGraw, PhD
Diana Murray, PhD
Dimitar B. Nikolov, PhD
Dinshaw J. Patel, PhD
Nikola P. Pavletich, PhD
Marilyn D. Resh, PhD
Benoit Roux, PhD
Timothy A. Ryan, PhD
Stewart Shuman, MD, PhD
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Paul Tempst, PhD
Hao Wu, PhD
Jue Jillian Zhang, PhD

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Biochemistry and Structural Biology

The Biochemistry and Structural Biology Program offers opportunities to develop research training in the areas of molecular structure determination, molecular mechanism of membrane trafficking, protein folding, signal transduction, mechanisms, gene structure and nucleic acid chemistry. The Biochemistry and Structural Biology Program is a member of an Alliance of three Programs that includes Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology.

Overview of Research Activities

Molecular biochemistry and structure is studied at different levels by investigators in the Program. Olaf Andersen uses molecular modeling systems coupled with single-channel experiments to define the structure of ion conducting channels. Amy Lam utilizes biochemical approaches toward understanding the ubiquitin proteosome system. Christopher Lima studies molecular processes involved in protein sumoylation, lipids and mRNA maturation. Dimitar Nikolov also uses x-ray crystallography to study signal transduction elements of the nervous system, such as axon guidance molecules Nikola Pavletich analyzes the structures of oncogenes and tumor suppressors via x-ray crystallography. NMR approaches and studies of molecular dynamics are used by Dinshaw Patel to determine solution structures of nucleic acids.

Hao Wu is studying the structural mechanisms of receptor signal transduction for the TNF family receptors in cell survival and cell death using x-ray crystallography. David Eliezer studies the roles of nonnative states of protein in biology and disease.

The molecular mechanism of membrane trafficking are studied by several investigators. Frederick Maxfield's laboratory uses optical microscopy to observe and understand receptor trafficking and cell motility. Tim McGraw uses molecular cell biological methods to study general endocytic membrane recycling and insulin-regulated membrane trafficking. Tim Ryan uses quantitative optical methods to study synaptic vesicle recycling. Protein folding and translocation are studied by several investigators. Esther Breslow is currently studying how the structure of a pituitary protein, neurophysin, relates to oxytocin and vasopressin binding and function. Min Lu uses biophysical and molecular biological methods to study the structure and function of the HIV-1 envelope protein.

Several laboratories study signal transduction processes. Steven Gross is undertaking molecular studies to define nitric oxide biosynthesis and its physiological action. David Hajjar's laboratory is determining the structure-function relationship between lipoproteins and their receptors, and their impact on cholesterol trafficking. Jillian Zhang is studying the molecular mechanisms of cytokine-induced transcription activation in the JAK-STAT pathway. Richard Kolesnick examines how sphingomyelin and ceramide participate in signaling that can affect apoptosis in the cell. Marilyn Resh's laboratory focuses on the role of fatty acid acylation processes in the determination of the structure and functioning of signal transducing proteins.

DNA replication is studied by several investigators in the program. Jerard Hurwitz's laboratory studies DNA replication of SV40 DNA and DNA replication within eukaryotic cells. Kenneth Marians uses purified proteins to determine the enzymatic mechanisms required for DNA replication and the role of topoisomerases in this process. Stewart Shuman's laboratory examines transcription termination processes and topoisomerase function. Scott Keeney uses biochemical and genetic approaches to investigate meiotic recombination in yeast and mammals.

Nucleic acid and organic chemistry are also actively investigated in the program. Francis Barany studies protein-DNA interactions and uses protein engineering to study cancer. Hugh Robertson examines the structure and function of biologically active RNA molecules. Paul Tempst develops methods for ultra-microsequencing of proteins. Complete and current research descriptions can be found on the Graduate School Web site at http://biomedsci.cornell.edu.

Program Requirements

Admission

Admission to the Program is offered through the Allied Programs of Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology.
The Allied Program is intended to prepare students for a career in basic research and teaching in cell or developmental biology, genetics, molecular biology, biochemistry, structural biology or related disciplines. Students with a strong background in these areas are urged to apply.

The Graduate Record Examination (GRE) is required. Although the Programs do not require the advanced test in biology, chemistry, biochemistry or cell and molecular biology, it will be considered positively when applications are reviewed. Applicants from abroad are required to take the Test of English as a Foreign Language (TOEFL) examination.

Joint Curriculum

The Allied Programs of Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology offer a joint curriculum in biochemistry, structural, cellular, molecular and developmental biology. Students entering any of the three Programs will have the same course, laboratory rotation, and first-year exam requirements, as well as the same Admission to Doctoral Candidacy Examination (ACE). These requirements are outlined in the next section. Program affiliation will be determined by the choice of thesis laboratory, usually by the beginning of the second year.

Course of Study

In the first year students are expected to complete a required core curriculum consisting of the following courses:

- Molecular Genetics,
- Biochemistry and Structural Biology,
- Cell Biology,
- Gene Structure and Function,
- Logic and Critical Analysis and
- Graduate Research Seminar.

Before graduation, students must also complete two quarters of elective courses: Nucleic Acids, Molecular Biology of Cancer, Special Topics in Advanced Genetics, Methods in Biophysics or Developmental Biology. (Electives can be selected from the other programs as well).

Students are required to complete the core curriculum during the first year and are advised to spread out the elective course requirements over the second and third years.

Students in their second through fourth year are also required to take semester-long, in-depth Focus Groups. Focus Groups currently include Molecular Biochemistry and Biophysics Nucleic Acid Transactions & Genomic Integrity, Cell Structure and Function, Molecular and Cell Biology of Viruses and Micro-organisms, Tissue Biology and Development, and Cancer Biology. These groups will have a deep appreciation for the history of each field and will be in the format of a student-driven journal club. A detailed syllabus will be provided for each focus group prior to each semester. Students in their second through fourth year will be required to choose a first and second choice from a menu of six focus groups and will be placed in groups of 10–15 people. Each group will meet every other week and discuss two papers per session for

approximately 10 sessions per semester. For students beyond their fourth year, this course will be optional. This will be a pass/fail course. Attendance will be required throughout years two, three and four.

The Curriculum Committee may exempt a student from elective courses, if the Committee determines that an equivalent course has been taken at other undergraduate or graduate institutions. If a student wants to obtain a course exemption, a first-year advisor must be notified and a written petition submitted to the Curriculum Committee.

The official transcript reports four grade levels: Honors (A), High Pass (B), Low Pass (C), and Fail (F). Students are expected to perform at a level corresponding to High Pass (B average) in the core curriculum.

First-Year Review

At the end of the first year, a review of the student's progress will be administered through an oral examination given to each student to monitor progress and identify areas of strength and weakness.

Laboratory Rotations

Students rotate through three laboratories during the first year. Such rotations familiarize students with ongoing research in the program and provide a mechanism for selection of the thesis sponsor. Following each rotation, a written report is submitted by the student for approval by the first-year advisors.

Admission to Doctoral Candidacy

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Special Committee

The Special Committee consists of the thesis faculty sponsor (also known as the major sponsor) and two minor faculty sponsors. This committee is responsible for guiding the student's thesis research and for evaluating the student's progress. Completion of the PhD degree requires defense of an original research thesis.

Joint Program Retreat

Students have numerous opportunities to meet with the faculty, including at faculty talks by Research Focus Group leaders at the beginning of the first year and a joint retreat held at a resort outside the New York City area, during which faculty and students present and discuss their work.

Cell Biology and Genetics

Faculty

Rosemary F. Bachvarova, PhD
Craig T. Basson, MD, PhD
Robert Benezra, PhD
Anthony M. C. Brown, PhD
Michael A. Caudy, PhD
Ethel Cesarman, PhD
Raju S. K. Chaganti, PhD
Anna Di Gregorio, PhD
Nathan A. Ellis, PhD
Donald A. Fischman, MD
Robert P. Fisher, MD, PhD
James L. German III, MD
Filippo G. Giancotti, MD, PhD
Katherine A. Hajjar, MD
Eric C. Holland, MD, PhD
Maria Jasin, PhD
Xuejun Jiang, PhD
Johanna Joyce, PhD
Paul A. Marks, MD
Joan Massagué, PhD
Takashi Mikawa, PhD
Malcolm A. S. Moore, DPhil
Yutaka Nibu, PhD
Joel D. Pardee, PhD
Marilyn D. Resh, PhD
Richard A. Rifkind, MD, *Emeritus*
Enriqué Rodriguez-Boulan, MD
Neal Rosen, MD, PhD
Urs Rutishauser, PhD
Thomas H. Söllner, PhD
Ching-Hwa Sung, PhD
Harold E. Varmus, MD
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Overview of Research Activities

The research interests of the Cell Biology and Genetics faculty comprise a wide range of topics related to the control of normal and malignant cell growth and differentiation. Purified proteins, isolated cells and tissues, and whole organisms are all being exploited as model systems. A variety of molecular, cellular, and genetic techniques are being used to address the following questions: How is gene expression regulated? How are proteins folded and targeted to specific locations within the cell? How do cells interact, and how does this influence tissue function? How is the growth of normal and transformed cells regulated at the biochemical and genetic levels?

Control of gene expression by helix-loop-helix proteins is being studied at the molecular level by Robert Benezra, who is interested in regulation of differentiation, and by Michael Caudy, who is studying Drosophila neurogenesis.

The precise expression of tissue-specific proteins is critical for coordination of development and differentiation. Rosemary Bachvarova is studying the process of gastrulation in embryos. Several faculty are studying the molecular aspects of tissue formation, including muscle development (Donald Fischman) and heart and brain differentiation (Takashi Mikawa).

The biosynthesis and targeting of proteins to specific subcellular locations is being addressed using biochemical and cytological techniques. Enriqué Rodriguez-Boulan is involved in molecular and biochemical aspects of intracellular protein trafficking using cell-free systems, yeast, or polarized cells. Once proteins are targeted to specific locations, their ability to mediate cell-cell interactions at the membrane is precisely controlled, and this and signaling by cell-surface integrins (Carl Blobel, Filippo Giancotti) are major research interests.

Control of normal and malignant cell growth by oncogenes, growth factors and the cell cycle are major research themes in the Cell Biology and Genetics Program. The laboratory of Paul Marks and Richard Rifkind studies growth and differentiation of erythroleukemic cells. Joel Pardee studies regulation of cell motility and cell proliferation by the actin cytoskeleton in cancer. Anthony Brown is interested in signaling by the Wnt family of secreted proteins in development and cancer, Neal Rosen is examining the role of tyrosine kinases in human breast and colorectal cancer, and Marilyn Resh studies the mechanisms of membrane binding and signaling by viral and cellular oncoproteins. The molecular mechanism of growth factor and receptor action is of interest to several laboratories, including neuronal growth factors (John Wagner), colony stimulating factors (Malcolm Moore), TGF beta (Joan Massagué), and G protein coupled receptors. Cell cycle control is a major thrust of the laboratory of Robert Fisher and interfaces with the growth control mechanisms studies by several other faculty members (Marks, Rosen, Massagué).

Human genetic abnormalities at the chromosomal level are being studied with the goal of designing effective therapies to treat human diseases. Raju Chaganti uses cytogenic methods to identify genetic alterations in human tumors. James German's laboratory analyzes defects in Bloom's syndrome. Maria Jasin is developing gene targeting methodology to target chromosomal breaks, while Hugh Robertson is exploiting ribozymes to cleave harmful RNAs. Complete and current research descriptions can be found on the Graduate School Web site at http://biomedsci.cornell.edu.

Program Requirements

Admission

Admission to the Cell Biology and Genetics Program offers advanced study leading to the PhD degree and is provided by the Allied Programs in Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology. The program is intended to prepare students for a career in basic research and teaching in cell or developmental biology, genetics, molecular biology, biochemistry, structural biology or related disciplines. Students with a strong background in these areas are urged to apply.

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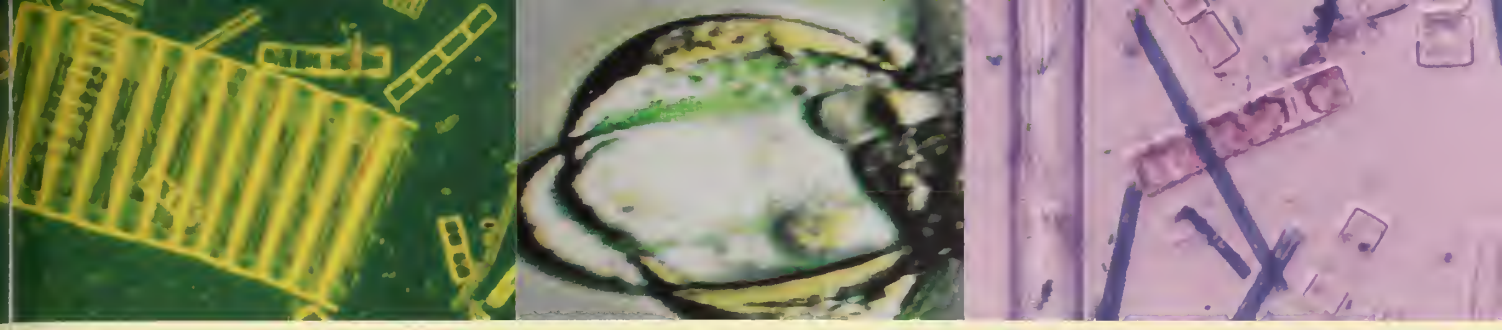

Immunology and Microbial Pathogenesis

Faculty

James P. Allison, PhD
Andrea Cerutti, MD
Ethel Cesarman, PhD
Selina Chen-Kiang, PhD
Hearn Cho, MD, PhD
Mary K. Crow, MD
Lisa R. Denzin, PhD
Aihao Ding, PhD
Bo Dupont, MD, DSc
Sabine Ehrt, PhD
Michael S. Glickman, MD
Ulrich Hämmerling, PhD
Alan N. Houghton, MD
Lionel B. Ivashkiv, MD
Hsiou-Chi Liou, PhD
Theresa Lu, MD, PhD
Xiaojing Ma, PhD
Noel Maclaren, MB, ChB
Eric Meffre, PhD
John P. Moore, PhD
William A. Muller, MD, PhD
Henry Murray, MD
Carl F. Nathan, MD
Richard J. O'Reilly, MD
Eric Pamer, MD
David N. Posnett, MD
Luminita Pricop, MD
Michel Sadelain, MD, PhD
Jane E. Salmon, MD
Derek B. Sant'Angelo, PhD
Kendall A. Smith, MD
Thomas J. Templeton, PhD
Marcel R. M. van den Brink, MD, PhD
Marc E. Weksler, MD
Hao Wu, PhD
Jue Jillian Zhang, PhD

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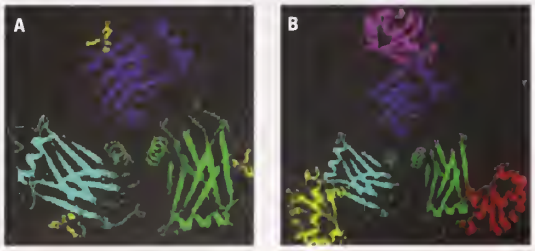
Overview of Research Activities

Immunity is the ability of the inherited genome in a body to restrict the replication of the noninherited genomes in the same body, whether they arise exogenously by infection or endogenously by mutation as in cancer. This ongoing struggle forces host and pathogen to co-evolve, drives the host to undertake post-meiotic genetic recombination and mutation to diversify the molecules it can use for recognition, and leads to a panoply of mechanisms for attack and counterattack.



Structural basis of two alternative modes of TRAF signaling by direct receptor coupling and by indirect coupling via the adapter protein TRADD. (A) Crystal structure of the trimeric TRAF domain of TRAF2 (shown as ribbon drawings in blue, cyan and green) in complex with a peptide from TNF-R2 (shown as yellow sticks next to the cyan molecule). Residues involved in trimerization are also shown between the cyan and blue molecules. (B) Crystal structure of the trimeric TRAF domain of TRAF2 (shown in blue, cyan and green) in complex with the N-terminal domain of TRADD (shown in red, magenta and yellow). The trimeric nature of TRAF2, revealed by these structural studies, provides the mechanism by which TRAF proteins respond to receptor trimerization. (Hao Wu's lab)

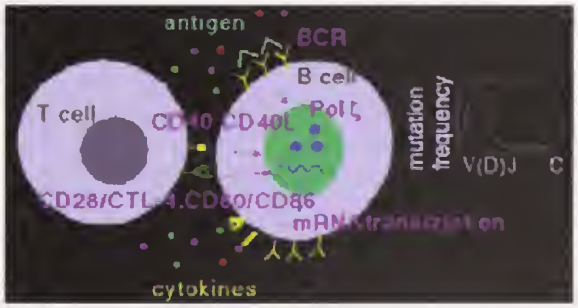
These elements combine to make Immunology an extraordinarily exciting discipline, whose study is facilitated by ready access to the only monodisperse, migratory cells in the postnatal mammal outside of gametes. These cells overcome distance and frequent shifts in locale to coordinate their behavior by releasing some of the most potent signaling molecules in nature. The same can be said of microbial pathogens. The Immunology and Microbial Pathogenesis Program brings together for research and teaching a diverse set of scientists who seek to understand how these remarkable genes, cells and molecules fight infection, cancer and grafted cells, how they misfire to cause autoimmune disease, and how some microbes evolve the ability to use the mammalian body for replication of their own genomes.

One class of lymphocytes, T cells, develop in the thymus. Derek Sant'Angelo studies how T cells develop, how they are negatively and positively selected according to their predetermined ability to recognize antigen, and how their specificity affects their ability to protect the host from infection. Lisa Denzin investigates how antigen-presenting cells choose and display pieces of antigens for recognition by T cells.

Other major classes of lymphocytes, B cells and antigen presenting cells, arise in the bone marrow. They are essential for the production of antibodies. Selina Chen-Kiang investigates the control of B cell differentiation and cancer by the cell cycle and apoptosis. Hsiou-Chi Liou's research centers on the role of NF-kB proteins in B cell activation and differentiation. Andrea Cerutti is interested in how tumor necrosis factors control B cell development, and Eric Meffre focuses on human B cell differentiation and autoimmunity. Cells in the immune system regulate each other by releasing signaling proteins called cytokines. Kendall Smith focuses on the role of interleukin-2 in activation and proliferation of lymphocytes and natural killer (NK) cells, while Xiaojing Ma analyzes how interleukin-12 regulates the development of protective cell-mediated immunity. Cytokines as well as cell surface molecules affect cell function through specialized signal transduction pathways. Lionel Ivashkiv and Jillian Zhang study the Jak-STAT signaling pathway in transcriptional activation and inflammatory diseases. Hao Wu uses structural biology to define the interactions of signal transduction elements in the family of tumor necrosis factor receptors. Ulrich Hämmerling studies the role of vitamin A and its metabolites in lymphocyte signaling and differentiation. Co-receptors and inhibitory receptors on T cells and NK cells such as KIRs also signal through specialized pathways. These are under investigation by Bo Dupont.

Theresa Lu studies how chemokines orchestrate the development and operation of the immune system. William Muller addresses the biology of adhesion molecules responsible for the binding and emigration of leukocytes across vascular endothelium. Carl Nathan's research is focused on the molecular mechanisms whereby neutrophils and macrophages kill infectious organisms such as the tubercle bacillus and the enzymes used by Mycobacterium tuberculosis to persist in the host. Sabine Ehrt takes a genetic approach to the mutual responses of M. tuberculosis and the mammalian host. Michael Glickman analyzes products of M. tuberculosis that engage the immune system. Tom Templeton studies the biology of the malaria parasite, Plasmodium falciparum, in both human and mosquito hosts. Henry Murray studies how T cells and macrophages cooperate to produce cytokines that limit replication of a protozoan pathogen, Leishmania. John Moore and David Posnett study the immune response to viruses, including the human immunodeficiency virus (HIV). Eric Pamer focuses on development of T cell memory to bacterial, viral and fungal infections. Aihao Ding is analyzing how macrophages regulate their response to microbial products. Alan Houghton, Jim Allison and Hearn Cho study the host immune response to cancer cells and are developing vaccines to immunize the host. The role of human herpesvirus (HHV)-8 in lymphoid transformation is the focus of Ethel Cesarman's research.

Mary (Peggy) Crow examines the T cell repertoire in autoimmune diseases and T cells ligands that regulate B cell activation and death. Noel Maclaren studies the role of autoimmunity in diabetes. Receptors for immune complexes of antigen and antibody profoundly affect the biology of phagocytic cells in autoimmunity, as studied by Jane Salmon. Eric Meffre investigates the basis of autoantibody formation. Changes in the immune system that occur during aging are Marc E. Weksler's focus. Richard O'Reilly and Marcel van den Brink study graft-versus-cancer reactions and graft-versus-host disease (GVHD), a complication of bone marrow transplantation, and are developing therapeutic strategies to prevent and treat this disease. Michel Sadelain is developing gene therapy approaches to GVHD as well as other genetic diseases using retrovirus vectors.



Ig gene hypermutation in B cells. Induction of Ig hypermutation requires engagement of B cell antigen receptor for antigen (BCR) and co-engagement of CD40 and CD80/CD86 by CD154 (CD40L) and CD28/CTLA-4 on T cells. BCR engagement transduces a signal that modulates expression of DNA polymerases of the translesion UmuC/DinB/Rev/Rad30 family and in particular polymerase zeta and polymerase eta. This results in introduction of base mismatches, i.e., point-mutations, in Ig variable genes and the bcl-6 transcriptional repressor

Fundamental Immunology

Quarters I and II of the course provide a comprehensive overview of basic immunology beginning with the innate immune responses, followed by a study of the main aspects of acquired immunity. Specific interactions of target cells and T cells that are regulated by the MHC molecule and peptide antigens on the target cell and the antigen specific T cell receptor are studied. The generation and molecular structure of B and T cell antigen receptors, and signaling through immune receptors, are covered in detail. Lastly, the development of antigen-specific T and B cells, and specific roles for some cytokines/lymphokines are also important topics. Quarters III and IV of the course cover in more depth T and B cell mediated immunity and topics of clinical relevance, such as microbial immunity, allergy, autoimmunity, tumor immunology, congenital and acquired immunodeficiencies, transplantation immunology, and immunotherapy. All the topics are studied though lectures and in-depth review of selected articles. The course is directed by Dr. Ethel Cesarman. Quarters I–IV, annually.

Microbial Pathogenesis

This course provides an overview of bacterial, protozoan and metazoan pathogens and the diverse mechanisms by which they elicit disease in humans. Select topics will also be presented on the evolution and diversity of cellular and genetic systems in human pathogens. The course includes discussion of pathogen immune evasion strategies, and will therefore assume Fundamental Immunology as a prerequisite or concurrent course. The course is directed by Sabine Ehrt and Thomas Templeton and will be taught jointly with faculty from Rockefeller University and will meet in both sites. Quarters III and IV, annually.

Advanced Topics in Immunology

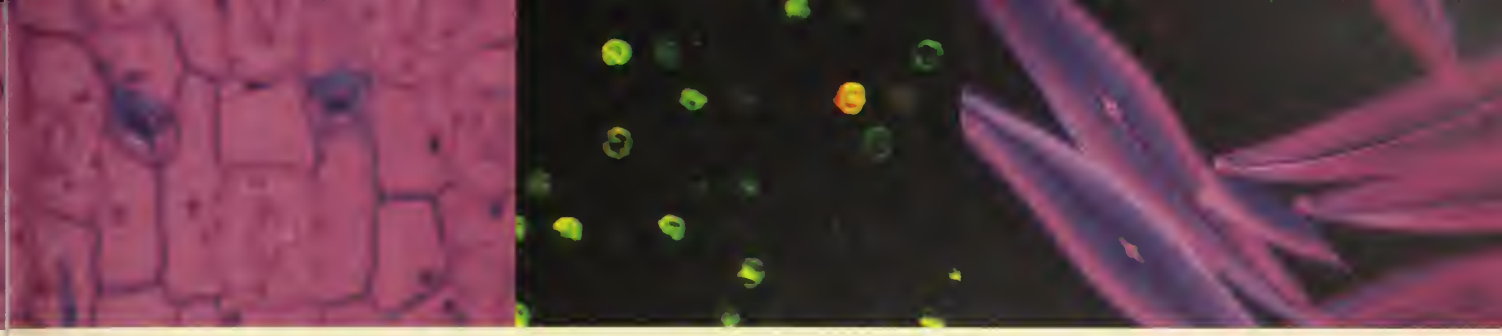
This course, in modular format, is designed to teach selected topics, in depth, including historical overviews, underlying principles, current status and significance for contemporary Immunology. Moreover, attempts will be made to connect immunological specialization with general principles of Biology and Biochemistry. The course will be open to all students and postdoctoral fellows. First- and second-year students will be required to take three modules for credit. Planned topics will include B cell development, T cell development, signal transduction, apoptosis, tumor immunology and developmental immunology. Other modules will be added ad hoc. This course is directed by Dr. Ulrich Hämmerling.
Quarters I–IV, annually.

Immunology Graduate Research in Progress

This course is designed to provide all Immunology and Microbial Pathogenesis Program graduate students with experience in preparing their experimental data for oral presentations. Each student is required to give several talks based on their research. The course is directed by Dr. Andrea Cerutti, Dr. Marcel van den Brink, Dr. Luminita Pricop. Quarters I–IV, annually.

Seminars in Immunology

This course is designed to offer all graduate students in the program an exposure to cutting-edge research by national and international leaders in all fields of immunology, including natural immunity, B and T cell biology, immunity to infectious agents and tumors. The course is directed by Dr. Derek Sant'Angelo, Dr. Xiaojing Ma and Dr. Lionel Ivashkiv. Quarters I–IV, annually.



Molecular Biology

Faculty

Kathryn Anderson, PhD
Francis Barany, PhD
Mary Baylies, PhD
Peter Besmer, PhD
Anthony M. C. Brown, PhD
Kirk W. Deitsch, PhD
Erik Falck-Pedersen, PhD
Lorraine J. Gudas, PhD
Anna-Katerina Hadjantonakis, PhD
William K. Holloman, PhD
Jerard Hurwitz, PhD
Prasad Jallepalli, MD, PhD
Scott Keeney, PhD
Thomas J. Kelly, MD, PhD
Andrew Koff, PhD
Elizabeth Lacy, PhD
Neal F. Lue, MD, PhD
Kenneth J. Marians, PhD
Pamela B. Meluh, PhD
Carl F. Nathan, MD
Pier Paolo Pandolfi, MD, PhD
John H. J. Petrini, PhD
Mark Ptashne, PhD
Luis E. N. Quadri, PhD
Chris Sander, PhD
Dirk Schnappinger, PhD
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Overview of Research Activities

Regulation of cell growth is a shared and unifying research interest to members of the Molecular Biology Program. The molecular pathways involved in control of cell growth have proven to be remarkably intricate, tying together nearly all the fundamental processes of cellular metabolism. For example, the products of oncogenes and tumor-suppressing and tumor-enhancing genes have been discovered to participate in pathways as seemingly diverse as signal transduction, repair of damaged DNA, regulation of gene expression, and control of the cell cycle. The research efforts of the faculty of Molecular Biology can be grouped under three broad topics: (1) mechanisms of differentiation, growth control and development, (2) mechanisms of DNA replication, DNA repair and chromosome maintenance and (3) transcriptional control of gene expression and mRNA biosynthesis.

Signal transduction is a critical step in the control of cell growth and proper developmental regulation. Kathryn Anderson, who studies the manner in which the maternal-effect genes regulate pattern formation in the developing embryo, and Mary Baylies, who is investigating how the Twist gene product controls cell fate determination in the mesoderm, use Drosophila as a model system to analyze development. Another major experimental system for the study of development is the mouse. Elizabeth Lacy has been isolating genes required for early development, whereas Pier Paolo Pandolfi has constructed mouse strains inactivated in genes known to be involved in the development of acute promyelocytic leukemia. Andrew Koff has developed a mouse model system that allows him to study the effects of deregulation of cell cycle control in a complex organism. How activated receptor complexes transmit information to control the growth state of a cell is under study by several investigators. Peter Besmer studies the mechanism of action of the c-kit receptor tyrosine kinase, whereas Lorraine Gudas is interested in the effects of retinoids on cell growth. Anthony Brown is elucidating the intracellular signaling pathways through which the Wnt family of proteins act. Often, only a very small amount of proteins involved in such pathways are available for analysis. Paul Tempst develops methods for ultra-microsequencing of proteins.

The biological mechanisms that mediate chromosome duplication are addressed in a variety of systems ranging from bacteria to humans. Kenneth Marians is investigating the protein-protein interactions required to make the E. coli replisome a super-efficient protein machine. Jerard Hurwitz is defining the proteins required for eukaryotic replication and how they interact with the cell cycle machinery. The molecular basis of DNA recognition by DNA binding proteins is under study in Francis Barany's lab. Several laboratories are combining the power of genetics and biochemistry to study aspects of DNA metabolism. The enzymatic machinery involved in repairing damaged DNA is studied in the laboratory of William Holloman. Scott Keeney is characterizing the genes and mechanisms that are essential to chromosome rearrangement during meiosis. Pamela Meluh is interested in the biology of the centromere-kinetochore complex involved in chromosome segregation during mitosis, and Neal Lue is dissecting the enzymatic machinery required for telomere maintenance and replication in yeast.

Basic aspects of gene expression are studied by a number of different investigators. The nature of protein/protein complexes that bind to DNA and act as transcriptional regulators is studied by Mark Ptashne. Using a variety of model systems, several laboratories are studying the essential pathways of mRNA processing. Stewart Shuman investigates the enzymatic mechanisms of transcription initiation, elongation and termination using yeast and Vaccinia virus as a model. Beate Schwer uses yeast genetics and biochemistry to dissect the biochemistry of mRNA splicing. Erik Falck-Pedersen uses another eukaryotic virus, adenovirus, as a model to study gene transduction and regulation of mRNA 3′-end formation in mammalian transcription units.

Complete and current research descriptions can be found on the Graduate School Web site: http://biomedsci.cornell.edu.

Program Requirements

Admission

Admission to the Molecular Biology Program offers advanced study leading to the PhD degree and is provided by the Allied Programs in Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology. The program is intended to prepare students for a career in basic research and teaching in cell or developmental biology, genetics, molecular biology, biochemistry, structural biology or related disciplines. Students with a strong background in these areas are urged to apply.

The Graduate Record Examination (GRE) is required. Although the Programs do not require the advanced test in biology, chemistry, biochemistry or cell and molecular biology, it is strongly encouraged and will be considered positively when applications are reviewed. Applicants from abroad are required to take the Test of English as a Foreign language (TOEFL) examination.

Joint Curriculum

The Biochemistry and Structural Biology, Cell Biology and Genetics, and the Molecular Biology Graduate Programs offer a joint curriculum in biochemistry, structural, cellular, molecular and developmental biology. Students entering any of the three Programs will have the same course, laboratory rotation, and first-year exam requirements, as well as the same Admission to Doctoral Candidacy Examination (ACE). These requirements are outlined in the next section. Program affiliation will be determined by the choice of thesis laboratory, usually by the beginning of the second year.

Course of Study

In the first year students are expected to complete a required core curriculum consisting of the following courses:

- Molecular Genetics
- Biochemistry and Structural Biology
- Cell Biology
- Gene Structure and Function
- Logic and Critical Analysis and
- Graduate Research Seminar

Before graduation, students must complete two quarters of elective courses: Nucleic Acids, Molecular Biology of Cancer, Special Topics in Advanced Genetics, Methods in Biophysics or Developmental Biology. (Electives can be selected from the other programs as well).

Students are required to complete the core curriculum during the first year and are advised to spread out the elective course requirements during the second and third years.

Students in their second through fourth year also required to take semester-long, in-depth Focus Groups. Focus Groups currently include Molecular Biochemistry and Biophysics Nucleic Acid Transactions & Genomic Integrity, Cell Structure and Function, Molecular and Cell Biology of Viruses and Micro-organisms, Tissue Biology and Development, and Cancer Biology. These groups will have a deep appreciation for the history of each field and will be in the format of a student-driven journal club. A detailed syllabus will be provided for each focus group prior to each semester. Students in their second through fourth year will be required to choose a first and second choice from a menu of six focus groups and will be placed in groups of 10–15.

Each group will meet every other week and discuss two papers per session for approximately 10 sessions per semester. For students beyond their fourth year, this course will be optional. This will be a pass/fail course. Attendance will be required throughout years two, three and four.

The Curriculum Committee may exempt a student from elective courses, if the Committee determines that an equivalent course has been taken at other undergraduate or graduate institutions. If a student wants to obtain a course exemption, Beate Schwer, one of the first-year advisors, must be notified and a written petition must be submitted to the Curriculum Committee.

The official transcript reports four grade levels: Honors (A), High Pass (B), Low Pass (C), and Fail (F). Students are expected to perform at a level corresponding to High Pass (B average) in the core curriculum.

First-Year Review

At the end of the first year, a review of the student's progress will be administered through an oral examination given to each student to monitor progress and identify areas of strength and weakness.

Laboratory Rotations

Students rotate through three laboratories during the first year. Such rotations familiarize students with ongoing research in the program and provide a mechanism for selection of the thesis sponsor. Following each rotation, a written report is submitted by the student for approval by the first year advisors.

Admission to Doctoral Candidacy

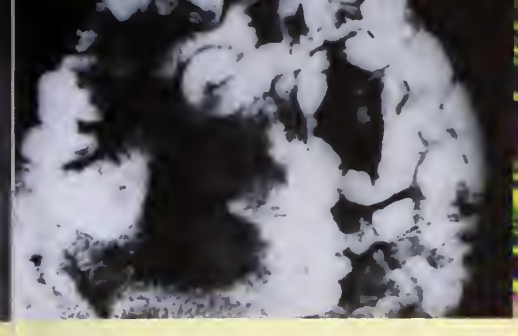
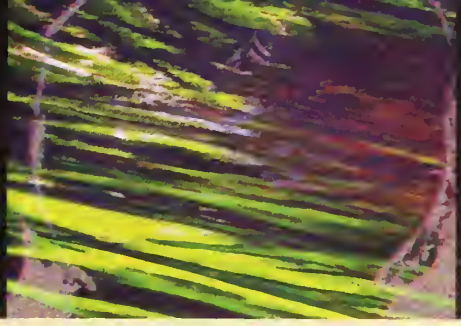
The Admission to Doctoral Candidacy Examination (ACE) is administered in two sections: a written examination and an oral examination. For the written exam the student prepares a written research proposal on a topic selected by the student and approved by the ACE committee. The written proposal is reviewed by the committee and returned to the student with a written critique. The oral exam tests the student's ability to respond to the comments in the critique, as well as the student's general knowledge. Students must also submit a three- to four-page description of their thesis project, including aims and methods, which will be reviewed by the Special Committee approximately three months later. All students are expected to take the Admission to Doctoral Candidacy Examination in the spring of their second year.

Special Committee

The Special Committee consists of the thesis faculty sponsor (also known as the major sponsor) and two minor faculty sponsors. This committee is responsible for guiding the student's thesis research and for evaluating the student's progress. Completion of the PhD degree requires defense of an original research thesis.

Joint Program Retreat

Students have numerous opportunities to meet with the faculty, including at faculty talks by Research Focus Group leaders at the beginning of the first year and a joint retreat held at a resort outside the New York City area, during which faculty and students present and discuss their work.

Neuroscience

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B. J. Casey, PhD
Michael A. Caudy, PhD
Arthur J. L. Cooper, PhD
Silvia Finnemann, PhD
Donald A. Fischman, MD
Daniel Gardner, PhD
Gary E. Gibson, PhD
Gunnar K. Gouras, MD
Bernice Grafstein, PhD
Neil L. Harrison, PhD
Barbara L. Hempstead, MD, PhD
Xin-Yun Huang, PhD
Constantino Iadecola, MD
Charles E. Inturrisi, PhD
Tong H. Joh, PhD
Lonny R. Levin, PhD
Chenjian Li, PhD
Giovanni Manfredi, MD, PhD
Teresa A. Milner, PhD
Dimitar B. Nikolov, PhD
Michiko Okamoto, PhD
Gavril W. Pasternak, MD, PhD
Virginia M. Pickel, PhD
Jerome B. Posner, MD
Keith Purpura, PhD
Enriqué Rodriguez-Boulan, MD
M. Elizabeth Ross, MD, PhD
Urs Rutishauser, PhD
Timothy A. Ryan, PhD
Thomas H. Söllner, PhD
Jin H. Son, PhD
Lorenz P. Studer, MD
Ching-Hwa Sung, PhD
Miklos Toth, MD, PhD
Jonathan D. Victor, MD, PhD
Bruce T. Volpe, MD
John A. Wagner, PhD

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Overview of Research Activities

The unifying theme of the Neuroscience Program is a common interest in the formation, function and aging of the nervous system. Students in the Neuroscience Program study the development, structure and physiology of the nervous system, using a wide variety of scientific disciplines, including molecular genetics, biochemistry, pharmacology, neuroanatomy, electrophysiology, molecular biology, computational neuroscience and behavior. They work at the molecular, cellular and organism levels, targeting the nervous system in rodents, birds, Drosophila, reptiles and Aplysia, as well as in humans. The research areas of the Program cover the entire range of neuroscience, including the regulation of neural development, neuronal plasticity, control of neurotransmitter synthesis and release, learning, the response of neurons and neural tissue to injury, the regulation of gene expression, endocrine function, vision and other sensory systems, information processing and behavior. Many members of the Program have a special interest in questions that are particularly relevant to human disease, and their research has important implications for topics such as the regulation of pain, neurodegenerative diseases such as Alzheimer's disease and Parkinson's disease, neural tumors, stroke, addiction and aging. The research interests of the faculty can be grouped into six major areas:

- neural disease,
- synaptic transmission,
- developmental neurobiology and regeneration,
- cognitive and computational neuroscience,
- neuropharmacology and
- vision

Neural Disease

The majority of the faculty in the program have strong interests in human neurological disease, and research in this area is fostered by the Institute for Human Neuroscience and the NIH training grant "Molecular Mechanisms of Neurological Disease," which is directed by John Wagner and Flint Beal. Flint Beal studies mechanisms of neurodegenerative disease, including Alzheimer's disease and amyotropic lateral sclerosis. Susan Browne studies mechanisms of Huntington's disease, while Giovanni Manfredi focuses on the involvement of mitochondria in neurodegenerative disease. CJ Li produces and studies transgenic mouse models of Huntington's Chorea and other neurodegenerative diseases. John Blass is interested in the molecular basis of Alzheimer's disease and neural degeneration. Michael Caudy is mapping genes that contribute to neurodegeneration. Ching-Hwa Sung is interested in the retinal dystrophies that cause blindness; in particular, how defects in protein targeting contribute to this pathology. Arthur Cooper is interested in neurotoxicology, amino acid metabolism and energy production in Alzheimer's disease and during ischemia. John Blass studies inborn errors of metabolism, especially defects that contribute to the development of Alzheimer's disease. Gary Gibson is interested in signal transduction and oxidative processes in the neurodegeneration associated with Alzheimer's disease, ischemia, and metabolic disease.

A large number of investigators are interested in stroke and cardiovascular disease. Bruce Volpe studies the effect of ischemia and trauma on pathological processes and changes in brain structure and function. He is also determining the effects of robot-assisted training on recovery in stroke patients. Constantino Iadecola is interested in neural degeneration after ischemia. The biology of cancer presents several problems that sets brain cancers apart from other forms. Jerry Posner studies the antigenic responses to cancer that induce neural degeneration (para-neoplastic syndromes). Ronald Blasberg uses Positron Emission Tomography (PET) to image brain tumors and to study tumor phenotype. He combines gene transfer technology and imaging of reporter gene expression to elucidate cellular and molecular processes, including signal transduction and the expression of therapeutic genes. Jin Son is using neuron-specific promoters to develop animal models of neurodegenerative disease and to produce neural tumors and cell lines in targeted neural populations. Elizabeth Ross studies the genetics of brain development and origins of birth defects involving neural proliferation, differentiation, and neuronal migration. These studies model human neural tube defects (spinabifida and anencephaly) and cognitive defects, including mental retardation and epilepsy.

Synaptic Transmission

The study of signaling among neurons and between neurons and other cells lies at the heart of neural functioning, so nearly all laboratories have an interest in this area; but several of our faculty focus strongly on the action of neurotransmitters and their receptors. Neil Harrison studies receptors for the inhibitory neurotransmitter GABA, their mechanisms of activation and modulation by endogenous modulators and drugs. Regulation of the rate of neurotransmitter release is a key regulator of information processing in the nervous system. Tim Ryan uses optical techniques to study the fundamental mechanism of neurotransmitter release. Thomas Söllner focuses on the role of SNARE proteins in vesicle docking and fusion and the role of SNARE proteins in maintaining vesicle flow, axonal transport and neuronal polarization. Understanding signaling among neural cells is greatly facilitated by understanding the connections among nerve cells at the anatomical

level, an approach used by many members of the Program. Notably, Virginia Pickel is targeting opioid and catecholamine receptors and neurotransmitter transporters in basal ganglia and their implications for reward and addiction. Teresa Milner is elucidating receptor selectivity of the transmitter components of the septohippocampal pathway that underlies learning and memory.

Developmental Neurobiology and Regeneration

Lorenz Studer studies neuronal stem cells and their potential for transplant and regeneration, for example in Parkinson's disease. Stewart Anderson investigates the origins and fates of cortical interneurons and their possible dysfunction in schizophrenia. Harriet Baker studies the factors responsible for the maintenance of neural phenotype in the olfactory system and John Wagner studies the role of peptide growth factors in the visual system. Michael Caudy studies the role of basic helix-loop-helix proteins in the development of the Drosophila nervous system. John Wagner and Michael Caudy are collaboratively studying the role of bHLH proteins, especially HES-1, in the development of vertebrate nervous system. Jin Son is using promoter analysis to determine the factors that control differentiation of specific cell population in the nervous system. Donald Fischman is interested in the development of the neuromuscular junction. Tong Joh is using neural-specific promoters to understand regulated transcription in the nervous system and as tools to understand how inappropriate gene expression can perturb developmental processes. Barbara Hempstead studies the role of neurotrophin receptors in the development of the neural crest and the retina. Urs Rutishauser investigates cell-cell interaction in the nervous system with a special interest in the role of neural cell adhesion molecules (NCAMs) and polysialic acid on neural migration and axon guidance. Bernice Grafstein studies axonal transport and regeneration as well as the development of the pia-arachnoid, which helps provide an appropriate environment for neural development. Dimitar Nikolov studies structure and function of axon guidance molecules, including ephrins, netrins, and semaphorins and their receptors.

Cognitive and Computational Neuroscience

Keith Purpura is interested in how attention influences cortical processing and how neural assemblies can represent the external world and influence behavioral tasks. B. J. Casey uses functional and structural MRI, high density electrical recording, and human genetics to study the development of cognitive and reward systems and their disruption in developmental disorders. She also examines neural and behavioral plasticity following perinatal insults and environmental stressors. Jonathan Victor studies signal processing and information coding in the nervous system. Daniel Gardner combines neurophysiology and artificial intelligence to elucidate the principles used to form neural networks. He also develops computer databases and programs to promote information exchange among scientists and to facilitate integration of neuroscience data.

Neuropharmacology

Charles Inturrisi and Gavril Pasternak are interested in the neuropharmacology of the opiates and their receptors. Many faculty are interested in drug abuse and the use of opiates for the control of pain. These efforts are supported by a training grant that is directed by Charles Inturrisi, "Pharmacology and Neuroscience of Drug Abuse," which also supports several students. Michiko Okamoto is interested in the neuropharmacological basis of alcohol, benzodiazepine and barbiturates. Ronald Blasberg uses PET to image opioid receptors, while Virginia Pickel and Teresa Milner study the localization of opiate peptides and their receptors at the ultrastructural level. Charles Inturrisi and Gavril Pasternak focus on the

molecular basis of opiate receptor function, tolerance and dependence. Xin-Yun Huang studies the ways GTP binding proteins and tyrosine phosphorylation are involved in transmitter signaling. Miklos Toth introduces germ line mutations into serotonin receptors to study their function. Lonny Levin is interested in signal transduction by various forms of adenylate cyclase in Drosophila and vertebrate systems, as well as the role of cAMP in cross talk among receptor systems. He recently isolated a novel soluble adenylate cyclase. Since the ultimate purpose of the nervous system is to regulate behavior, several members of the program are attempting to determine the structural and biochemical basis of behavior. Miklos Toth uses genetic approaches to generate animal models of disease. His primary interest is the serotonergic system, which is associated with anxiety disorders, obsessive-compulsive behavior and aggressiveness in humans. He is also studying a transgenic model of epileptic seizure. James Gibbs is interested in the regulation of feeding behavior, including its regulation by neuroendocrine function, neuropeptides and dietary fat.

Vision

The visual system is a premier system to study sensory processing in both the retina and the brain. Members of the Dyson Vision Institute, directed by Enriqué Rodriguez-Boulan have a special interest in this area. Work in vision research is supported by an NIH training grant, "Tri-Institutional Training Program in Vision Research," which provides support for several students. Ching-Hwa Sung is interested in the molecular mechanism used by photoreceptors to target opsin in photoreceptors and related sorting mechanisms that establish polarity in neurons and epithelial cells. Enriqué Rodriguez-Boulan and Silvia Finneman focus on the cell biology of the retina, on how the retinal pigment epithelium promotes photoreceptor survival and how its dysfunction causes retinal degeneration. Jonathan Victor is interested in processing of visual information in both the retina and the cortex. Keith Purpura is interested in communication among the cortical areas involved in processing visual information. Complete research descriptions can be found on our Web site at http://www.biomedsci.cornell.edu.

Program Requirements

Mission

The Neuroscience Program is a multidepartmental, multidisciplinary effort by faculty, students and fellows to provide an outstanding education in neuroscience. We believe that graduate education is an important step on a career pathway to academics, a specialized research institute, the pharmaceutical or biotechnology industries, government, business or education. We expect our graduates to be able to think independently and creatively, to have a demonstrated ability to make important discoveries and to communicate their ideas effectively.

Admission

Applicants to the program are expected to have had undergraduate training in biology, organic chemistry, physics, and mathematics. Students entering this program after attaining an MD or a master's degree can have a modified educational program. Graduate Record Examination scores, transcripts and supporting letters must be submitted with the application. Candidates considered for admission are invited to visit the program.

Course of Study

The program of research, course work, seminars and independent study is individualized. Students are expected to spend time working closely with members of the faculty whose research approach is complementary to their interests. There are regularly scheduled seminars where work in progress is presented and discussed. By these means, the students are afforded the broadest possible view of the neurosciences during their graduate training. Depending on their background and interests, students will be expected to take a course in basic neuroscience and in at least one upper-level course in cell biology, molecular biology, biochemistry or pharmacology. The Program offers courses in molecular, biochemical, cellular, and systems neurobiology. Students will select advanced graduate courses in the neurosciences and related fields and undertake independent study to deepen their knowledge in areas of interest and to develop a minor specialty. There is sufficient flexibility in choosing elective courses that students may specialize in a particular area(s), including molecular neurobiology, developmental neurobiology, systems neuroscience, neuropharmacology, or neurophysiology. Throughout their training, students are expected to participate in the weekly Progress in Neuroscience seminar series and the seminar companion course, Current Topics in Neurobiology.

Retreat

Each year the program organizes an academic retreat that includes talks, poster sessions and discussions by students and faculty. This retreat provides an informal setting away from the city, where members of the program can interact and discuss their work. Senior students also present their work at the student-organized Vincent du Vigneaud Symposium and the Progress in Neuroscience series.

Laboratory Rotations and Thesis Research

Laboratory rotations allow students to experience research firsthand and to acquaint themselves with the research faculty of the program. Students are expected to do three rotations of about two months each, but they may do more rotations before choosing their thesis advisor. Thesis research is guided by the student's major sponsor and a committee that includes at least two additional faculty.

Admission to Doctoral Candidacy

Before the end of the second year, students will organize a special committee and take the qualifying Admission to Doctoral Candidacy exam (ACE). In the Neuroscience Program this exam is a defense of both the thesis research proposal and an original nonthesis research proposal.

Pharmacology

Faculty

Geoffrey W. Abbott, PhD
Jochen Buck, MD, PhD
Luca Cartegni, PhD
Samuel Danishefsky, PhD
Diane F. Felsen, PhD
Steven Gross, PhD
Lorraine J. Gudas, PhD
Neil L. Harrison, PhD
Hugh C. Hemmings, Jr., MD, PhD
Charles E. Inturrisi, PhD
Samie R. Jaffrey, MD, PhD
Richard N. Kolesnick, MD
William Lee Kraus, PhD
Roberto Levi, MD
Lonny R. Levin, PhD
Yueming Li, PhD
Michiko Okamoto, PhD
Gavril W. Pasternak, MD, PhD
Marcus M. Reidenberg, MD
Arleen B. Rifkind, MD
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Anthony Sauve, PhD
David A. Scheinberg, MD, PhD
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Derek Tan, PhD
Miklos Toth, MD, PhD

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Overview of Research Activities

The research activities of the Pharmacology Program are directed at understanding how drugs and chemicals modify biological systems. Drugs can act at many different levels of organization. For example, many drug targets reside within cells and function at the level of gene expression. Dr. Gudas is analyzing how derivatives of vitamin A (retinoids) modulate gene expression to regulate both cellular differentiation and cellular proliferation during development and in the process of tumor formation. Numerous retinoids are used clinically in cancer prevention and treatment. Dr. Rifkind is investigating how a cytoplasmic receptor for dioxin controls the expression of certain enzymes (cytochrome P-450s) and how this results in the diverse toxicities of dioxins and the polychlorinated biphenyls (PCBs). Dr. Kraus studies the functions of the estrogen receptor and its role in gene transcription. Alterations in pre-mRNA splicing are strongly associated with tumor progression and Dr. Cartegni is developing a pharmacological approach to control aberrant splicing events in tumors. Dr. Jaffrey uses molecular and chemical biology approaches to study RNA trafficking in neurons. An additional focus of his laboratory is proteomics, the systematic identification and quantitation of proteins in a cell or tissue. Dr. Toth has identified a gene involved in RNA trafficking and translation and is studying how dysfunction of this gene leads to epilepsy; he is also creating transgenic mouse models to study other types of neurological diseases. Often the actions of drugs are mediated by specific receptors located on the cell surface. Dr. Pasternak is using molecular and biochemical techniques to characterize the receptors for analgesic drugs such as morphine. Dr. Inturrisi has found that NMDA receptor antagonists are able to prevent morphine tolerance and is examining how this receptor and the opioid receptors interact. Dr. Szeto is developing novel opioid drugs for use as obstetrical analgesics. The drugs are evaluated for their effects on the mother and the fetus. Dr. Scheinberg is using monoclonal antibodies as drugs that specifically target sites on tumor cells. Dr. Li is decoding the molecular logic of intramembrane proteolysis that has emerged as a novel signaling paradigm, such as gamma-secretase-mediated signal transduction of APP, Notch and ErbB4.

Many drugs interact with ion channels and Dr. Harrison is studying how anesthetics interact with these channels. Dr. Abbott recently discovered a family of potassium channel accessory subunits and is investigating their ubiquity and necessity for generation of native potassium currents using electrophysiology and RNAi gene silencing; mutations in some of these proteins lead to cardiac arrhythmia.

Receptors are linked to intracellular events by signal transduction pathways. Many members of the Pharmacology Program work to understand these signaling cascades in the hopes of identifying novel drug targets and therapeutic strategies. Dr. Levi is investigating transductional mechanisms of a novel histamine receptor subtype (the H3-receptor), which he discovered to be activated in myocardial ischemia and afford cardioprotection. Dr. Kolesnick has discovered a new signal transduction pathway, the sphingomyelin pathway, and is identifying how this pathway signals in response to receptor activation. Drs. Levin and Buck have discovered a novel signaling pathway leading to production of the ubiquitous second messenger cAMP. The soluble adenylyl cyclase provides a local source of cAMP for intracellular compartments. This signaling pathway plays a role in cell metabolism and in sperm activation. Dr. Gross is defining signal transduction processes involving nitric oxide, a reactive gas that is produced by mammalian cells and signals by chemical modification of protein targets. Nitric oxide plays a physiological role in regulating vascular function, host defense and neuronal signaling—too much nitric oxide appears to cause clinically important vascular disease, inflammation and neurodegeneration. Dr. Hemmings is interested in the critical role played by protein phosphorylation in the effects of general anesthetics on synaptic transmission. Dr. Neal Rosen is developing new inhibitors of protein kinases to block the dysregulation of growth and inhibition of apoptosis that characterize advanced human cancer. Dr. Sauve is utilizing chemical, enzymological and pharmacological approaches to study the ADP-ribosyl-transfer enzymes CD38, Sir2 and Poly-ADP-ribosyl-polymerase (PARP). The recent discovery of important roles of these NAD+ metabolizing enzymes in cell signaling, and in regulating genome stability and lifespan make this an important research area at the present time.

Dr. Tan is developing diversity-oriented organic syntheses to identify new small molecule probes for studying biological systems. Dr. Danishefsky's lab focuses on synthesizing new drugs for cancer therapy. Dr. Felsen is examining the mediators of inflammation in the genitourinary tract, the receptors involved, and new drug therapies designed for renal and bladder diseases. Dr. Okamoto is involved in the development of new muscle relaxants for use during anesthesia. Dr. Reidenberg's clinical pharmacological studies are aimed at understanding the sources of variation in drug responses. He is evaluating the mechanisms of the antineoplastic and antifertility effects of gossypol.

Program Requirements

Admission

A baccalaureate degree with a strong background in the natural sciences and/or health sciences is required for admission. Results of the Graduate Record Examination (verbal, quantitative and analytical) are required for PhD applicants, and submission of results of the advanced test in biology or chemistry are strongly recommended.

Course of Study

In the first two years, students are required to complete the following core curriculum courses:

- Introduction to Pharmacological Principles (A full-year course comprising four courses: Chemical Biology, Signal Transduction, Principles and Systems, and Molecular Pharmacology of Cancer),
- Logic and Experimental Design,
- Neuropharmacology, I and II and
- Seminars in Pharmacology

Each student also completes at least two electives by June of the second year. These electives are selected from courses offered by the Weill Graduate School of Medical Sciences.

Program Supervision and Laboratory Rotations

The Program director and the Curriculum Committee will supervise the student's graduate program until the student selects a faculty member to serve as the major sponsor. Three laboratory rotations are required of each student. These rotations provide the opportunity for the student to participate in the diverse research activities that are available within the program. This experience is designed to assist the student in the selection of major and minor sponsors for the thesis research.

Admission to Doctoral Candidacy

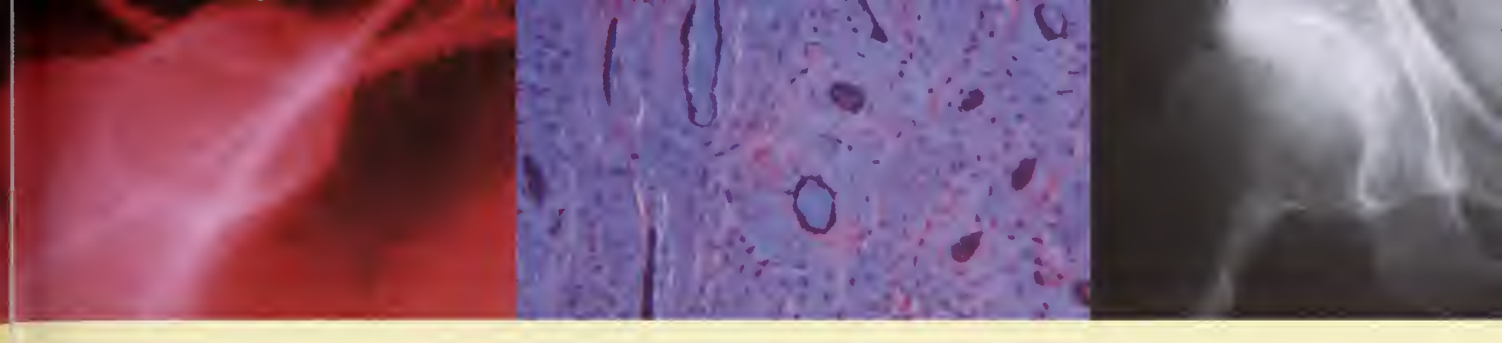
The Admission to Doctoral Candidacy Examination consists of two parts: a uniform written exam and an oral exam that includes discussion of a written research proposal. It is expected that most students will take this exam by the end of their second year.

Special Committee

The Special Committee consists of a major faculty sponsor and two minor faculty sponsors. The Program director will assist the student in the selection of the major (thesis) advisor, and the thesis advisor will assist in the selection of the two minor sponsors.

Retreat

The Pharmacology Program holds a retreat each year in the spring, usually for two days at a country inn. Students, postdoctoral fellows and faculty of the program gather for a series of informal talks and a poster session to exchange the latest scientific information. The retreat provides a relaxed setting for new and incoming graduate students to meet other students, fellows and faculty members in the Program.



Physiology, Biophysics and Systems Biology

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Overview of Research Activities

From different but complementary perspectives, and through taking advantage of advanced specialized methods, the biomedical research disciplines of Physiology and Biophysics seek to discover, analyze and explain the functions of the human body's building blocks: cells, tissues and organs. The availability of information from genomics, imaging and proteomics, combined with the power of computational methods, has enabled entirely new approaches for making these discoveries and relating them to the most basic molecular mechanisms. Most importantly, these new approaches make it possible to integrate into the research activities of the Program faculty the findings from genetics, structural biology, and cell and molecular biology with principles and representations from physics and engineering. Together, they create a systems-level view of function in physiological components (e.g., from the cell to the heart, and from the neuron to the nervous system). This new integrative perspective, termed Integrative Systems Biology, complements and completes the study of structure and mechanisms of the body's building blocks from their embryonic development to their mature function, in both healthy and diseased states. The Physiology, Biophysics and Systems Biology (PBSB) graduate Program is designed to engage the students in education through research in current and innovative aspects of these three synergistic components of modern biomedicine.

Biophysical and Physiological Mechanisms of Membranes and Membrane Proteins

Work in the labs of Drs. Andersen, Christini, Palmer, Roux, and H. Weinstein has uncovered remarkable molecular properties of channels and receptors that make cell function and intercellular communication possible in the brain and throughout the body. The discrete mechanisms of these complex molecules were revealed from creative experimental designs, as well as computational modeling and simulation. In parallel, the discovery of some previously unknown genes and their function has enabled the laboratories of Drs. Huang and Weinstein to outline the signal transduction mechanisms that connect the membrane protein signals to gene expression and regulation. All these insights enable as well the development of novel therapies and the design of targeted drugs.

Quantitative and Integrative Systems Biology

With quantitative methods of mathematical modeling, computational simulation and bioinformatics, the laboratories of Drs. Clancy, Christini, Gardner, Leibler, A. M. Weinstein, and H. Weinstein have represented the components and calculated the parameters of fundamental mechanisms in neurophysiology and in the function of organs such as the heart. The approaches include construction and interpretation of gene or cell signaling networks for which a variety of questions are answered, such as the robustness and sensitivity of networks with respect to biochemical modifications of their components, the resistance of genetic networks to molecular noise, such as the noise connected with fluctuations in the number of different components, and the precision and establishment of proportions (scaling) in spatial pattern formation. The formal and quantitative models can create a new perspective on how the cellular and network properties of individual neurons, and the information they convey, give rise to the complex behavior of the brain. The mathematical models are able to integrate experimental information from basic and clinical studies to reveal the most fundamental underpinning of complex physiological mechanisms, and the mode of perturbation by disease or genetic mutations. For example, mathematical modeling of solute and water transport across the renal epithelia are developed to produce a mathematical model of the mammalian distal nephron in order to assess the extent to which known defects can account for observed solute excretion patterns. Conversely, simulations of clinical tests of distal nephron function can be used to evaluate their accuracy in defining a specific transport defect. Similarly, modeling of ion channels in heart cells, where molecular defects disrupt the delicate balance of dynamic interactions between the ion channels and the cellular environment, results in simulations that reveal how the resulting altered cell function manifests itself as cardiac arrhythmia.

Organogenesis and Physiological Genomics

To answer the key questions about the development of the complex functions in specialized cells of tissues and organs, the laboratories of Drs. Basson, Herzlinger and Mikawa identify both the genes that regulate differentiation and the nature of the inductive signal that triggers multipotent organogenic progenitors to differentiate. For example, molecular genetic techniques were applied to identify novel genes that regulate cardiac differentiation and morphogenesis, in order to understand a number of congenital and inherited disorders of human cardiac growth and development. Similarly, a single gene product was shown to trigger embryonic renal cell differentiation. The life span of animals is also genetically controlled, and the rate of cellular aging can be regulated by genes that directly affect intracellular mechanisms for protection, turnover, and repair of macromolecules and cell membranes. The lab of Dr. Huang has developed a genetic screen for gene mutations that extend life-span in Drosophila, and has isolated a mutant methuselah (mth) that displays increased average life-span and enhanced resistance to various forms of stress. The mth gene encodes a membrane protein (G protein-coupled receptor) that signals to biochemical mechanisms regulating the aging process.

Aspects of Biomedical Imaging and Bioengineering

Faculty members with laboratories at the Hospital for Special Surgery (Drs. Boskey, Torzilli) and in the Imaging Center (Ballon, Wang) complement the quantitative research aspects with perspectives on physiological processes in tissue engineering, and the biophysics of biomedical imaging. The research directions include quantitative aspects of the physiology of biomineralization, analyzed with biophysical methods from the structure of mineral and matrix in health and disease, and the engineering of soft tissues. Such approaches take advantage of and are often supported by development and application of novel techniques for imaging tissues and mechanisms, for example, of malignancies of the bone marrow, breast and other organs. New methods are being developed to assess properties and understand mechanisms of drug delivery, so as to provide insights needed for new therapies and tissue engineered products.

More complete research descriptions are provided on the PBSB Web site:
http://physiology.med.cornell.edu/school/PBSB.html

Admission

The Program in Physiology, Biophysics and Systems Biology welcomes applications from candidates with:

- a baccalaureate or higher degree,
- appropriate preparation in the biological or physical sciences and
- ability to pursue advanced study and research.

Classroom, Laboratory, and Beyond

The PBSB educational program is designed to prepare students for and engage them in some of the most advanced and powerful modes of research in biomedicine. An essential component of the Program is formation of a close working relationship between students and faculty. To this end, two PBSB faculty advisors are assigned to each incoming student by the Program Director.

The course of study in the PBSB Program is organized into modular courses and seminars offering education at the conceptual level, as well as in the experimental and computational tools of the component disciplines (Physiology, Biophysics and Systems Biology), and offers immersion in specific research topics.

Specific Courses offered by PBSB include: Essentials of Human Physiology, Acquisition of Organ Function, Physiological Geonomics, Bioinformatics, and PBSB Seminar Series. Many students choose to enroll in one or two courses offered by other Weill Graduate School Programs, including Logic and Design, Cell Signaling, Advanced Cell Biology, Developmental Biology, Biochemistry and Structural Biology. In addition, students are encouraged to audit courses from other institutions in the New York metropolitan area if a course of interest is not offered on the Weill Campus.

Each PBSB student is required to complete three laboratory rotations during the first two years of residency. These rotations acquaint the student with research opportunities within the Program and enable the student to choose a thesis project and advisor based on firsthand experience in the laboratory.

The student and the Faculty Advisory Committee are free to design an individualized program of study in preparation for the Admission to Doctoral Candidacy Exam (ACE). The intent of this exam is to assess the student's broad knowledge of biomedical research, train students for oral presentations and the preparation of research proposals. The exam consists of a written and oral component and is expected to be completed by June of the second year of residency. After the student completes the ACE exam, a major thesis sponsor will be selected and thesis research initiated. At this time, the student will be advised by a Special Committee consisting of the two previously appointed Faculty Advisors, the major thesis sponsor, and at least one other faculty member with expertise in the thesis research area. The average residency period to obtain a PhD is five years.

Updated information about the Program and faculty contacts can be found at http://physiology.med.cornell.edu

Clinical Epidemiology and Health Services Research

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Overview

The program of study leading to the Master of Science (MS) degree in Clinical Epidemiology and Health Services Research is designed for those who wish to plan, implement and analyze quantitative and qualitative research studies, using appropriate research designs. The core of the curriculum includes research methodology, biostatistical techniques, data management, decision analysis, health economics and program evaluation. Graduates of the program will be prepared to pursue academic careers in a variety of settings where data are required to answer complex questions. The emphasis is on training clinician researchers to teach research methods, conduct methodologically rigorous and scientifically sound studies, evaluate programs and perform cost-effectiveness and cost-benefit studies in a variety of populations.

Program Requirements

Admission

Applicants for admission must be graduates of an approved college or university and must show evidence of fitness for advanced work as indicated by their scholastic records, training and experience.

All documents, including translations of documents, must be official—that is, they must bear original signatures and seals. Application forms or supporting documents cannot be faxed; only correspondence can be faxed.

No final action can be taken on applications until the following supporting documents have been reviewed:

1. Complete official transcripts of all previous college and university work, including summer schools. A final transcript must be supplied after the completion of current degree requirements.
2. At least two letters of recommendation from professors or other professionals with knowledge of the applicant's abilities in the areas of academic aptitude and achievement and/or in carrying out professional work and responsibilities.
3. An official Test of English as a Foreign Language (TOEFL) score report if English is not the applicant's native language. These reports must be sent directly to the Weil Graduate School of Medical Sciences by the Educational Testing Service, Princeton, NJ.
4. A personal statement providing a concise description of the applicant's research experience and research interests. (The essay should not exceed one typed page, single-spaced, with a font not smaller than 12 points.)
5. An updated curriculum vitae.

Admission to the program requires an MD degree, an RN certificate, or a graduate degree in a clinical health–related field, with three years of work experience and acceptance into the Weill Graduate School of Medical Sciences. In most instances, physicians will have completed residency programs and nurses will have had several years of work experience prior to enrollment.

Application materials must be completed and returned to the office of the Joan and Sanford I. Weill Graduate School of Medical Sciences.

The completed application and all supporting documents will be screened initially by the Clinical Epidemiology and Health Services Research Program faculty. Personal interview meetings will be scheduled and held with each potential applicant. Applications for July admission and all credentials, including official transcripts of records from all colleges and universities attended, must be received by the deadline of May 1. A nonrefundable fee of $50 payable to the Joan and Sanford I. Weill Graduate School of Medical Sciences of Cornell University is charged for filing an application for admission.

Course of Study

For full-time students, the two-year program begins with an intensive summer session, with the remainder of the course work completed during the subsequent fall and spring semesters. The second year is devoted to the development, administration and analysis of a specific research project. The program can also be completed on a part-time basis—up to a maximum of four years—to accommodate individuals with differing needs and limited availability. The format for each of the curriculum units is small-group seminars with interactive lectures. Each of the sessions has required homework assignments; the candidate must successfully complete each assignment to pass the course.

The two-year program of study for the MS degree in Clinical Epidemiology and Health Services Research includes required and elective courses. Students must complete all of the required introductory and advanced seminars, including weekly research methodology, health policy and multidisciplinary health services research seminar/conferences. Students are also expected to complete elective courses, the selection of which is guided by each student's area of interest.

Eligibility for the MS degree in Clinical Epidemiology and Health Services Research requires the satisfactory completion of no less than 35 credits of course work and the completion of an integrative project and a research thesis. The projects are at the core of the Clinical Epidemiology and Health Services Research program. The most important foundation for preparing individuals for future careers is the utilization of new skills and knowledge to conceive, design and conduct research projects, with faculty guidance and support. After completing the curriculum and project, students will be required to defend their findings.

Refunds

Part of the tuition will be refunded if the student obtains official certification of leave of absence or withdrawal from the Joan and Sanford I. Weill Graduate School of Medical Sciences during the semester. Students who terminate their registration during a regular term in this manner will be charged tuition from the registration day to the effective date of the certificate as follows: first week, 10 percent; second week, 20 percent; third week, 30 percent; fourth week, 40 percent; fifth week, 60 percent; sixth week 80 percent; seventh week, 100 percent. No charge will be made if the effective date of leave or withdrawal is within the first six days of the term.

Fellowship Training Opportunity

Health Services Research Training Fellowships are available for physicians who have completed an accredited residency training program in any clinical area. The fellowships are open to citizens and permanent residents of the United States. The fellowships seek physicians who are committed to the application of health services research and clinical epidemiology, and who are committed to pursuing a research career. These fellowships are administered through the Division of General Internal Medicine at Joan and Sanford I. Weill Medical College of Cornell University.

Additional Areas of Concentration

In addition to the topics described in the Programs of Study, the following Additional Areas of Concentration are also available to interested students:

Area of Concentration	See Program In
Cancer Biology	Cell Biology Molecular Biology Pharmacology
Chemical Biology	Tri-Institutional Chemical Biology PhD Program
Computational Biology	Biochemistry and Structual Biology Physiology, Biophysics and Systems Biology
Developmental Biology	Cell Biology and Genetics Immunology Neuroscience Pharmacology Physiology, Biophysics and Systems Biology
Microbiology	Immunology Molecular Biology

Course Offerings

Allied Programs: Biochemistry and Structural Biology, Cell Biology and Genetics, and Molecular Biology Programs

Biochemistry and Structural Biology

Biochemistry and Structural Biology is a two-quarter course that is a core requirement of the program. The course covers equilibria, bond formation, protein chemistry and structure, nucleic acid chemistry and structure, ligand binding, chemical and enzyme kinetics, enzyme reaction mechanism, principles of macromolecular analysis, principles of protein purification, and principles of macromolecular recognition and specificity. Quarters I and II; offered annually.

Molecular Genetics

The course is organized around the principles of genetic analysis, with examples chosen from organisms that best illustrate those principles. The course is based on lectures and problem sections. The topics to be covered include the nature of the gene, linkage and physical maps, chromosome structure and segregation, recombination mechanisms, nature of mutations, mutations as tools to dissect gene function, transposition, genetic analysis of the regulation of gene expression.

Cell Biology

This course explores key aspects of cell biology at a detailed molecular level. The focus is on the integration of structure/function relationships for proteins in cell membranes, cytosol, and nucleus. Specific topics include membrane structure, protein biosynthesis and vesicular trafficking, cell architecture and motility, receptor and oncogene mediated signaling, intercellular interactions, cell-cell adhesion, and the cell cycle. The course consists of two lectures per week, plus one interactive discussion section involving current research papers.

Gene Structure and Function

A two-quarter course that explores the regulatory mechanisms governing the flow of information in cells from DNA to RNA to protein. The first module of the course deals with DNA replication, recombination and repair and introduces basic principles of DNA topology and protein-DNA interactions as they apply to these and other processes. In the next module, the fundamentals of gene structure and transcription are presented. Topics include: structure and function of transcription factors and RNA polymerases; mechanisms of transcriptional activation and repression; transcriptional control of the cell cycle; and the effects of chromatin structure on transcription. The final module covers post-transcriptional processing of RNA, including its translation into protein. Topics include RNA splicing and editing, polyadenylation, mRNA transport and, finally, regulation of translation. Quarters III and IV; offered annually.

Logic and Critical Analysis

This course is designed to teach the critical analysis necessary to be a successful scientist. Students read papers in the primary literature and discuss the experiments. It addresses the questions, What was the hypothesis? What were the experiments designed to test? What other information is necessary to interpret the experiment? Do the experiments accomplish this goal? What problems exist in the experiment? and Where might you go from here? To develop the critical analysis skills required, the first group of presentations will emphasize one or two figures in each paper. Following development of critical skills required to read the primary literature, two to three papers will be assigned as a thematic group by each instructor to be discussed sequentially. Quarters III and IV; offered annually. Dr. Andrew Koff and staff.

Graduate Research Seminar

This course represents an opportunity for the faculty and students of the program to hear the upper-class students describe their research in formal seminar presentations. Quarters I–IV; offered annually.

Nucleic Acids Enzymology

A formal course presenting the enzymological mechanisms and control of prokaryotic and eukaryotic transcription and DNA replication. Enzymes that alter DNA structure and shape are reviewed and topics in DNA repair and recombination are also covered. Quarters I and II; offered in alternate years. Drs. Kenneth Marians, Jerard Hurwitz and staff.

Molecular Virology

A formal course in which major emphasis is placed on the basic mechanisms in the biology of all animal viruses, including RNA and DNA tumor viruses. The topics considered include virus structure and composition; assay of viruses and viral-specific products; transcription and replication of viral nucleic acids; translation of virus-specific proteins; assembly of viral particles; structural and functional alterations in viral-infected cells, including transformation, pathogenesis of viral diseases and viral genetics. Quarters III and IV; offered in alternate years.

Molecular Biology of Cancer

This course presents an in-depth analysis of the mechanistic basis of cancer: the nature of the neoplastic cell phenotype, the genetic alterations found in cancer cells, and the functional mechanisms by which these alterations contribute to tumorigenesis. After an introduction to hereditary, viral, and environmental risk factors in cancer, the key role of deregulated cell cycle checkpoints is discussed, together with the mechanisms by which oncogenes and tumor oppressor genes affect growth regulation, apoptosis and DNA repair. Examples of specific types of malignancy are used to illustrate human cancer genetics, tumor progression, and the role of DNA rearrangements and genomic instability. Other topics include mechanisms of invasion, metastasis and tumor angiogenesis. The final module of the course considers how our understanding of the molecular basis of cancer can lead to novel methods of cancer therapy and prevention. The course format is a combination of lectures and discussion groups. Quarter III; offered annually.

Developmental Biology

Key concepts in developmental biology are presented and discussed, drawing on research from a number of model systems, including Drosophila, C. elegans, Xenopus, zebrafish, chicken and mouse. The course stresses genetic, cellular, molecular and comparative approaches to problems in development. During the first half, the course concentrates on early embryogenesis and pattern formation in the different model organisms, specifically axis determination, gastrulation and neurulation. This section of the course includes two practical lab sessions, which will provide firsthand experience with manipulating and analyzing embryos of different species. The second half of the course focuses on later developmental processes, including growth and patterning of the limbs, development of the nervous system and of sensory structures such as the eye, and the development of muscle, heart and lung. The course meets twice weekly and consists of lectures and interactive group discussions of classic and current research papers. Quarters I and II; offered annually.

Special Topics in Advanced Genetics

Specialized topics in advanced genetic analysis will be covered. Each four-week module will include both lectures and discussion of recent papers from the literature on a focused topic. Topics will change from year to year. Examples of topics to be covered include gene silencing in yeast and Drosophila, imprinting and X inactivation; sex determination, DNA repair and cancer genetics, genetic analysis of Drosophila wing development and genetic analysis of mammalian development. Quarters III and IV; offered annually.

Human Genetics

The aim of this course is to review the major topics in contemporary human genetics. The course will prepare students for advanced study in human genetics. Topics covered: linkage analysis and gene identification, cytogenetics, human genome project, molecular basis of human genetic disorders, immunogenetics, population genetics, human sex chromosomes, genomic instability syndromes, genetics of human cancer, complex diseases, mouse models for human disease and gene therapy. Lectures twice weekly. Quarter I; offered annually.

Immunology and Microbial Pathogenesis Program

Fundamental Immunology

Quarters I and II of the course provide a comprehensive overview of basic immunology beginning with the specific interactions of target cells and T cells that are regulated by the MHC molecule and peptide antigens on the target cell and the antigen-specific T cell receptor. The development of antigen-specific T cells in the thymus and their activation in the periphery, plus the development and activation of B cells, are covered in detail. Specific roles for cytokines or lymphokines in the immune response are also important topics. Quarters III and IV of the course cover the contribution of innate and antigen-non-specific mechanisms of host defense and topics of clinical relevance, such as microbial immunity, allergy, autoimmunity, tumor immunology, congenital and acquired immunodeficiencies, transplantation immunology and aging. Quarters I–IV; offered annually.

Advanced Topics in Immunology

This course, in modular format, is designed to teach selected topics, in depth, including historical overviews, underlying principles, current status, and significance for contemporary immunology. Moreover, attempts will be made to connect immunological specialization with general principles of biology and biochemistry. The course will be open to all students and postdoctoral fellows. First- and second-year students will be required to take three modules for credit. Planned topics include B cell development, T cell development, signal transduction, apoptosis, tumor immunology and developmental immunology. Other modules will be added ad hoc. Quarters I–IV; offered annually.

Immunology Graduate Research in Progress

This course is designed to provide all Immunology program students with experience in preparing their experimental data for oral presentations. Each student is required to give several talks based on their research. Quarters I–IV; offered annually.

Seminars in Immunology

This course is designed to offer all graduate students in the program an exposure to cutting-edge research by national and international leaders in all fields of immunology, including natural immunity, B and T cell biology and immunity to infectious agents and tumors. Quarters I–IV; offered annually.

Neuroscience Program

From Neuron to Brain

This course is intended to provide a solid foundation in neurobiology to incoming students of varied academic backgrounds. Fundamentals of neuroanatomy, neurophysiology and cell biology are combined with consideration of some important aspects of cellular and systems neuroscience. Quarters I and II.

Progress in Neuroscience (PINS)

This course is the seminar series in the Program in Neuroscience. Most lectures are given by speakers invited from outside the Cornell community, but speakers are also drawn from the Program in Neuroscience and scientists at Cornell with related interests. Quarters I–IV.

Neuroscience Faculty and Their Research

This course introduces students to the faculty of the Program in Neuroscience. Quarters I and II.

Molecular Neuropharmacology

This course combines consideration of the structure of the nervous system and the neuropharmacology of neurotransmitters in the context of the function of the nervous system. It provides an introduction to neuroanatomy and a more detailed consideration of receptors for the biogenic amines, GABA, and glutamate. Quarters III and IV.

Ion Channels of Excitable Membranes

This course reviews the structure and function of ion channels in neurons and other excitable tissues. The course begins with a review of classical Biophysics and describes the revolutionary impact of molecular biology techniques on the field, and concludes by considering the recent information on channel structures. Quarters III and IV.

Molecular Basis of Neurological Disease

This course will review current attempts to understand neurological disease from a molecular point of view. Students will learn how to apply the basic methods in molecular biology and molecular genetics to the study of neurological disease. Quarter IV, annually.

Neuropeptides

This mini-course considers the unique features of neuropeptides as neurotransmitters and neuromodulators in the CNS as well as their role in neuroendocrine regulation. It will focus on opiates and pituitary peptides as specific examples of this large class of signaling molecules. Quarter IV.

Drug Development: A Business Approach

Everyone in biomedical science and medicine will be interacting with biotechnology and pharmaceutical companies, but students are often unprepared to understand these companies as businesses, evaluate them as places to develop our careers, understand how they will impact our science, or appreciate how they will change health-care delivery. This seminar course will help educate students about how drugs and medical devices are developed and commercialized. The course will include presentations on drug development, clinical trials, the FDA, patent law, clinical trials, pricing policy, drug sales, financial analysis, and related topics. It will also include presentations on specific biotechnology and pharmaceutical companies, including an analysis of present and future performance. Students will be expected to actively participate in 15 meetings over a two-year period (there are 10 meetings each year), follow a single company for a year, and formally present a company and evaluate its prospects.

Pharmacology Program

Logic and Experimental Design

The objective of this interdisciplinary course is to present first-year graduate students with basic principles of cell function as described by biochemistry, cell and molecular biology, molecular pharmacology and electrophysiology. It is intended to lay a foundation for more specialized courses and laboratory research. The course consists of lectures, journal clubs and small group discussions. It is taught by faculty from throughout the Graduate School of Medical Sciences and is required for all incoming Pharmacology students. Quarters I and II, annually.

Principles of Pharmacology (4 Parts):

Quarter I: Chemical Biology

Students should develop an understanding of the chemical reactions used in biological and laboratory synthesis and manipulation of proteins, nucleic acids, lipids, and carbohydrates. Students should also develop an understanding for the chemical principles that underlie enzyme function. By the end of the course, students should be comfortable reading journal articles on chemical biology and will be expected to give an oral presentation and written report on a topic in the field.

Quarter II: Signal Transduction

The goal of the course is to provide students with an understanding of the basic recurring themes in cell signaling mechanisms and to familiarize the students with a majority of the key signal transduction pathways. Additionally, an emphasis is placed on (1) the use of pharmacologic and chemical tools to study problems in signal transduction and (2) structural insights into signaling mechanisms, based on x-ray, NMR and computational approaches. By the end of the course, the students should feel comfortable with reading and comprehending journal articles that relate to the latest findings in signal transduction.

Quarter III: Principles and Systems Pharmacology

Systems Pharmacology occupies the third quarter of the year-long Introduction to Pharmacological Principles. It is a 9-week course arranged into three parts or modules: 5 sessions in the first part covering general pharmacological principles, 9 sessions in the second part focusing on nervous and circulatory systems, and 10 sessions in the third and final module covering the remainder of the circulatory system along with host defense and endocrine systems. An understanding of systems pharmacology is necessary and valuable for all Pharmacology Graduate Students. Recommended textbook: Bertram G. Katzung, ed., *Basic and Clinical Pharmacology*, 8th edition.

Quarter IV: Cancer Pharmacology

Cancer Pharmacology will focus on the principles and applications of modern cancer therapeutic approaches. The topics considered range from traditional cytotoxic and anti-mitotic agents to natural products and their chemistry to biologic and immunologic therapies to rationally designed targeted small molecule inhibitors. Basic principles underlying mechanisms of cancer cell death, angiogenesis, and radiobiology and imaging are also covered. Course Organizer: Dr. David Scheinberg and Dr. Yueming Li

Neuropharmacology (2 Parts):

Quarter III: Genes, Drug and Behavior
Quarter IV: Neuropeptides and Drugs of Abuse

This course consists of modules 3 and 4 of the Genes, Drugs and the Brain (GD&B) course. This course is jointly sponsored by the Neuroscience and Pharmacology Programs. It is designed to present current concepts of the major central nervous system (CNS) neurotransmitters and their functional neuroanatomy. The course will integrate discussions of the mechanisms of neurotransmitter biosynthesis and release, receptor signal transduction and the alterations produced by CNS drugs. Quarters III and IV; offered annually.

Biostatistics

The course is targeted at individuals involved in clinical and biomedical research. The course consists of lectures and discussions on exploratory data analysis, basic concepts of statistical analysis, construction of hypothesis tests and confidence intervals, the development of statistical methods of analyzing data and development of mathematical models used to relate a response variable to explanatory or descriptive variables. Quarter I; offered annually.

Pharmacology Research Seminar

Topics of contemporary pharmacological interest and new concepts and methodological approaches in biological research will be presented by guest speakers from universities, pharmaceutical companies and pharmacology faculty members. The presentations are followed by a discussion session which provides an opportunity for students to meet and talk to leading scientists in the field. Details of events will be announced in advance. Quarters III and IV; offered annually.

Research in Pharmacology

Research opportunities may be arranged throughout the year for graduate students who are not majoring in pharmacology but who want some investigative experience in the discipline. Special opportunities are offered for work on the nervous and cardiovascular systems and in biochemical and clinical aspects of pharmacology.

Pharmacology Journal Club

This is an informal course, designed to improve skills in critical reading and oral presentation of scientific information. It is organized and administered by the graduate students in the Pharmacology Program and continues throughout the academic year.

Physiology, Biophysics and Systems Biology Program

Essentials of Human Physiology

This introductory course provides a framework for advanced studies in cell, organ and systems physiology. It includes independent readings from a graduate level human physiology text and weekly meetings with tutors. The tutors will facilitate a general discussion of the reading material and assist students in identifying unresolved issues in the independent readings. In addition, students will read and discuss a classical paper and a forefront paper related to the organ system under study.

Acquisition of Organ Function

A problem-based learning approach will be used to study the process of organogenesis. The course will be focused on general concepts mediating the formation of all organ systems using the developing kidney as a paradigm. Topics to be covered include the cell biological mechanims mediating the assembly of diverse cell types into an organ primordium, signaling between embryonic cells regulating organ architecture, and, finally, important parameters required for the onset of organ function.

Bioinformatics

This course begins with a discussion of the history, techniques and statistical analyses used in bioinformatics today. Students will begin to analyze how thesse tools can be used to predict RNA, gene and protein structure. The final two weeks of the course will be focused on systems biology, including current techniques used to model protein-protein interactions, protein networks and cell signaling.

Physiological Genomics of the Cardiovascular System

A journal club and discussion seminar approach will be used to study the process of gene regulation of cardiovascular organogenesis and function. The course will focus on fundamental advances in our knowledge in genomics and how genes regulate the structure, organization and activity of the heart and vasculature. Weekly sessions will address topics that range from molecular to cellular to tissue to organ to organismal events.

Physiology, Biophysics and Systems Biology Research Seminar Series

This required course exposes students to recent research developments in PBSB faculty focus areas including: Biophysical and Physiological Mechanisms of Membrane Protein Function, Quantitative and Integrative Biology Organogenesis, Physiological Genomics Biological and Biomedical Imaging

Physical Principles of Medical Imaging

This is a one-semester course covering the basic concepts of major modern diagnostic imaging technologies. Emphasis is placed on magnetic resonance imaging (MRI). Computerized tomography (CT) and ultrasound (US) are also covered. Students will gain fundamental technical knowledge of medical imaging and an overview of current status of medical imaging technologies. Quarters I and II; offered annually.

Energetics and Kinetics of Biological Processes

The objective of this course is to provide a rigorous description of the physical/chemical principles underlying some "simple" systems that recur in biology, with an emphasis on membrane-related events. The topics will include random events, electrodiffusion, chemical equilibrium, the two-state channel, ligand binding and receptor activation, complex gating mechanisms, channel-mediated ion movement and ion selectivity and conformational carriers and coupled transport systems. Quarters III and IV.

Mathematical Models of Membrane Transport

The general, thermodynamic description of membrane and epithelial transport will be reviewed. Comparison with kinetic descriptions of membrane transport will be considered, and the analysis of composite membrane systems will be examined as a prelude to the construction of epithelial simulations. Examples of such simulations will be used to examine transport along the kidney tubule under normal and pathological conditions. Quarters III and IV; offered annually.

Proseminar in Synaptic Physiology

The biophysics of synapses and their relation to behavior are explored by reading and discussion of seminal papers in the original literature. The first half of the course examines a model synapse, the mammalian neuromuscular junction, by intracellular recording, voltage clamping, noise analysis, and patch clamping. Topics in the second half include NMDA receptors, plasticity and neural networks. Minimum: five students. Quarter IV; offered annually.

Outreach Programs

Cornell University
Intercampus Student Exchange

Graduate students enrolled at the Weill Graduate School of Medical Sciences or at Cornell University in Ithaca may register for study with graduate faculty at either campus. Courses and research topics may be undertaken at either campus, depending on student need and resource availability.

ACCESS Summer Internship Program

The ACCESS Summer Research Program is an internship program for training underserved college students in the biomedical sciences. Interns are given hands-on experience in a biomedical research laboratory and are encouraged to apply to PhD programs. Selected students are placed in laboratories at the Weill Medical College under the mentorship of an experienced faculty member. In addition to the laboratory experience, students attend lectures and discussions aimed at enhancing their understanding of the current status of biomedical research, the different pathways for entering a research career, and the range of career opportunities available. Students also participate in weekly journal clubs, attend workshops that teach them how to prepare for interviews and seminars, and even take part in various social activities. The program lasts 10 weeks during the summer. This program is open to students who have excelled in their sophomore or junior years in college. At the end of 10 weeks, a celebratory award ceremony is held in which students give oral and poster presentations on their research. The students receive a stipend of $2,500 and are reimbursed up to $500 for travel expenses. Students who are not from New York City are provided with free on-campus housing. Applicants must be citizens or lawful permanent residents of the United States and must have individual medical insurance for the duration of the program. Applications must be received by February 1.

Administration: Françoise Freyre, MA, Assistant Dean,
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212-746-6120
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http://biomedsci.cornell.edu

Teaching Opportunities

Graduate student teaching assistants are selected for each Graduate School course by the course director. TAs perform a multiplicity of duties, including leading student discussion sections, preparing and grading examinations, and tutoring individual students. For their contributions to the Graduate School teaching mission, each TA is compensated with a cash honorarium of up to $1,500 per course, depending on the extent of their course duties. Teaching assistants are also acknowledged by a teaching credit entry on their official WGSMS transcript.

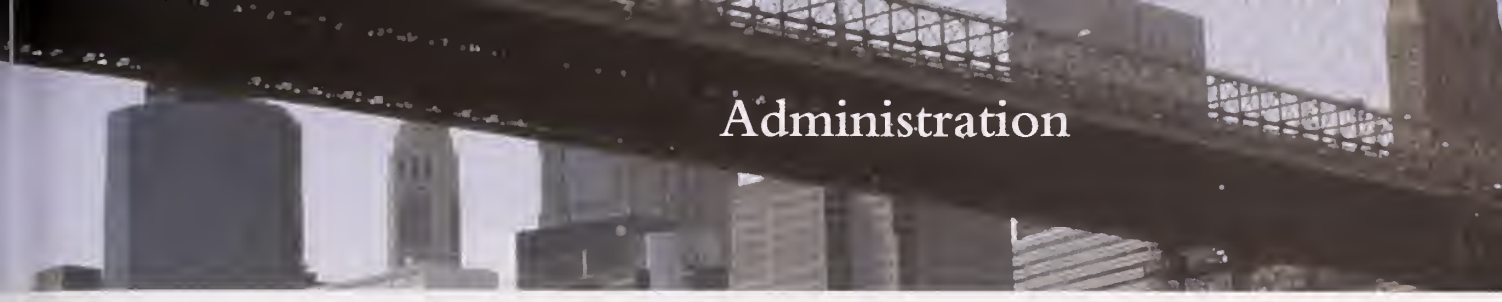
Middle School and High School Outreach

The Weill Graduate School of Medical Sciences Education Outreach Office, directed by Dr. Brian Turner, organizes several outreach programs targeting secondary-school science students in New York City. The aim is to help students gain a sound science education and motivate them to take an interest in medical science. Since its inception in 1999, the Outreach Office has organized workshops that have been attended by over 600 New York City high school and middle school science teachers. The workshops update the teachers' knowledge of biomedical science and provide labs and lecture materials for them to take back to their classrooms. WGSMS students have presented 40 lectures and labs on a diverse range of topics including DNA profiling, HIV, karyotype analysis, protein electrophoresis, bacterial transformation and genetic engineering.

As an aid to teachers who have attended our Professional Development Workshops, the Outreach Office provides on-site visits to local secondary schools. Since 1999, Outreach Office staff and Graduate School student volunteers have presented labs and lectures to over 3,000 New York City secondary- school students.

Cornell Science Challenge

The Cornell Science Challenge (CSC) is an enormously popular annual outreach project targeting science students at the East Side Middle School. Graduate students, postdoctoral fellows and faculty from WGSMS, Weill Medical College, the Sloan-Kettering Institute and The Rockefeller University spend one hour a week over a three-month period mentoring seventh-grade students. The students' focus is on designing and conducting a research project of their own choice. At the culmination of the mentoring program, their projects are judged at the day-long CSC Fair held at the Weill Medical College, where awards are given for "Best Scientific Method," "The Most Creative Project," and "The Best Presentation." Dr. Max Gomez, the science anchor for *NBC Nightly News*, presents these awards to the students. Since 1997, the CSC has reached over 900 middle school students. It is a unique program developed, organized and run by graduate students. By volunteering their time and sharing their expertise, CSC mentors have a strong, positive influence on students and their attitude toward science.



Administration

Weill Graduate School of Medical Sciences

Hunter S. Rawlins, *President of the University*
Antonio M. Gotto, Jr., *Provost of Medical Affairs*
David P. Hajjar, *Vice Provost and Dean*
Joel D. Pardee, *Associate Dean*
Françoise Freyre, *Assistant Dean*
Thomas J. Kelly, *Director, Sloan-Kettering Division*
Kenneth J. Marians, *Director of Graduate Studies, Sloan-Kettering Division*

WGSMS Executive Committee

David P. Hajjar, Chair, *ex officio*
M. Flint Beal
Mary Charlson
Erik Falck-Pedersen
Antonio M. Gotto, *ex officio*
Lorraine J. Gudas
Katherine A. Hajjar
James P. Allison
Thomas J. Kelly, *ex officio*
Kenneth J. Marians
Joan Massagué
Frederick R. Maxfield
Carl F. Nathan
Joel D. Pardee, *ex officio*
Dinshaw J. Patel
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Stewart Shuman
Harel Weinstein

Graduate Student Executive Council

Lucy Willis, *President*
Cali Howitt, *Vice President*
Carrie Garceau, *Treasurer*
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Anne Marie Hein, *Parliamentarian Committees*

Executive Committee
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Jeanne Farrell

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Jennifer Treweekj

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Ryan George

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Eduardo Gallo, *Security*
Sumit Niogi, *Appeals*
Jason Gray, *Webmaster*

Career Pathways
Jason Gray
Sindy Escobar Alvarez

International Student Committee
Ting Jia
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Program Representatives

Pharmacology
Chad Shelton
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Immunology
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Neuroscience
Bojana Zupan
Jym Ocbina
Eduardo Gallo

Allied Programs
Kelly Yule
Cali Howitt
Ryan George

Faculty

Abbott, Geoffrey W. (Pharmacology) Assistant Professor. BSc 1991, University of Durham (United Kingdom); MSc 1993, University of Leicester (United Kingdom); PhD 1996, University of London (United Kingdom)

Adelman, Ronald D. (Clinical Epidemiology) Associate Professor. MD 1978, Albert Einstein College of Medicine of Yeshiva University

Alexopoulos, George S. (Clinical Epidemiology) Professor. MD 1970, National University of Athens (Greece)

Allegrante, John P. (Clinical Epidemiology) Adjunct Professor. BS 1974, State University of New York, Cortland; MS 1976, PhD 1979, University of Illinois–Urbana-Champaign

Allis, C. David (Molecular Biology) Professor. BS 1973, University of Cincinnati; MS 1975, PhD 1978 Indiana University

Allison, James P. (Immunology and Microbial Pathogenesis) Professor. BS 1969, PhD 1973, The University of Texas, Austin

Andersen, Olaf S. (Physiology, Biophysics and Systems Biology; Biochemistry and Structural Biology) Professor. Candidatus Medicinae 1971, University of Copenhagen (Denmark)

Anderson, Kathryn (Molecular Biology) Professor. BA 1973, University of California, Berkeley; MS 1975, Stanford University; PhD 1980, University of California, Los Angeles

Anderson, Stewart A. (Neuroscience) Assistant Professor. BA 1984, Amherst College; MD 1989, University of Connecticut School of Medicine

Bachvarova, Rosemary F. (Cell Biology and Genetics) Professor. BA 1961, Radcliffe College; PhD 1966, The Rockefeller University

Baker, Harriet (Neuroscience) Associate Research Professor. BA 1963, Wells College; MS 1967, University of Illinois; PhD 1976, University of Iowa

Ballon, Douglas (Physiology, Biophysics and Systems Biology) Associate Professor. BS 1980, PhD 1985, Rutgers University

Barany, Francis (Molecular Biology; Biochemistry and Structural Biology) Professor. BA 1976, University of Illinois at Chicago Circle; PhD 1981, The Rockefeller University

Basson, Craig T. (Cell Biology and Genetics; Physiology, Biophysics and Systems Biology) Professor. AB 1982, Washington University, St. Louis, Mo.; MD-PhD 1990, Yale University School of Medicine

Baylies, Mary (Molecular Biology) Associate Professor. AB 1982, Dartmouth College; PhD 1991, The Rockefeller University

Beal, M. Flint (Neuroscience) Professor. BA 1972, Colgate University; MD 1976, University of Virginia

Benezra, Robert (Cell Biology and Genetics) Professor. BA 1975, University of Rochester; MA 1982, PhD 1986, Columbia University

Besmer, Peter (Molecular Biology) Professor. MS 1964, PhD 1969, Eidgenoessische Technische Hochschule (Switzerland)

Blasberg, Ronald G. (Neuroscience) Professor. BA 1961, Colgate University; MD 1967, Albert Einstein College of Medicine

Blass, John P. (Neuroscience) Professor. AB 1958, Harvard University; PhD 1960, University of London (United Kingdom); MD 1965, Columbia University

Blobel, Carl Peter (Cell Biology and Genetics) Professor. MD 1984, Justus Liebig University (Germany); PhD 1991, University of California, San Francisco

Blutt, Mitchell J. (Clinical Epidemiology) Adjunct Professor. BA 1978, MD 1982, MBA 1987, University of Pennsylvania

Boskey, Adele (Physiology, Biophysics and Systems Biology) Professor. BA 1964, Barnard College; PhD 1970, Boston University

Boutin-Foster, Carla (Clinical Epidemiology) Assistant Professor. BA 1990, New York University; MD 1994, State University of New York (Health Science Center at Brooklyn); MS 1999, Joan and Sanford I. Weill Graduate School of Medical Sciences of Cornell University

Breslow, Esther M. (Biochemistry and Structural Biology) Professor. BS 1953, Cornell University; MS 1955, PhD 1959, New York University

Briggs, William (Clinical Epidemiology) Assistant Professor. BS 1992, Central Michigan University; MS 1995, PhD 2004, Cornell University

Brown, Anthony M. C. (Cell Biology and Genetics; Molecular Biology) Associate Professor. BA 1977, MA 1979, University of Cambridge (United Kingdom); PhD 1981, University of Edinburgh (United Kingdom)

Browne, Susan E. (Neuroscience) Assistant Professor. BS 1989, University of Aberdeen (Scotland); PhD 1993, University of Glasgow (Scotland)

Bruce, Martha L. (Clinical Epidemiology) Associate Professor. BA 1974, Pomona College; MPH 1982, PhD 1987, Yale University

Buck, Jochen (Pharmacology) Professor. MD 1984, PhD 1985, University of Tübingen (Germany)

Camacho, Nancy (Physiology, Biophysics and Systems Biology). Associate Professor. BS 1985, McGill University; MS 1988, PhD 1991, Rutgers University

Campagne, Fabien (Physiology, Biophysics and Systems Biology) Assistant Professor. MS 1994, Joseph Fourier University (France); DEA 1995, PhD 1998, Henri Poincare University (France)

Cartegni, Luca (Pharmacology) Assistant Professor. MS 1991, PhD 1996, Universita degli Studi di Pavia (Italy)

Casey, B. J. (Neuroscience) Professor. BA 1982, MA 1984, Appalachian State University; PhD 1990, University of South Carolina Columbia, Columbia

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Caudy, Michael A. (Cell Biology and Genetics; Neuroscience) Associate Professor. PhD 1985, University of California, Berkeley

Cerutti, Andrea (Immunology and Microbial Pathogenesis) Assistant Professor. MD 1990, Padua University School of Medicine (Italy)

Cesarman, Ethel (Immunology and Microbial Pathogenesis; Cell Biology and Genetics) Associate Professor. MD 1981, Universidad Autonoma Metropolitana, Faculdad de Medicina (Mexico); PhD 1988, New York University

Chaganti, Raju S. K. (Cell Biology and Genetics) Professor. BS 1954, MS 1955, Andhra University (India); PhD 1964, Harvard University

Charlson, Mary E. (Clinical Epidemiology) Professor. BA 1968, Wellesley College; MD 1972, Yale University

Chen-Kiang, Selina (Immunology and Microbial Pathogenesis) Professor. BS 1965, National Taiwan University; MS 1967, Cornell University; PhD 1977, Columbia University

Cho, Hearn (Immunology and Microbial Pathogenesis) Assistant Professor. AB 1988, Princeton University; PhD 1995, Cornell University Graduate School of Medical Sciences; MD 1996, Cornell University Medical College

Christini, David (Physiology, Biophysics and Systems Biology) Assistant Professor. BS 1991, The Pennsylvania State University; MA 1993, PhD 1997, Boston University

Clancy, Colleen (Physiology, Biophysics and Systems Biology) Assistant Professor. BS 1994, Union College; PhD 2001, Case Western Reserve University

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Cooper, Arthur J. L. (Neuroscience) Research Professor. BSc 1967, MSc 1969, University of London (United Kingdom); PhD 1974, Cornell University Graduate School of Medical Sciences

Crow, Mary (Immunology and Microbial Pathogenesis) Professor. BA 1972, Manhattanville College; MD 1978, Cornell University Medical College

Crystal, Ronald C. (Physiology, Biophysics and Systems Biology) Professor. BA 1962, Tufts University; MS 1963, University of Pennsylvania; MD 1968, University of Pennsylvania School of Medicine

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Dupont, Bo (Immunology and Microbial Pathogenesis) Professor. MD 1966, University of Arhus (Denmark); DSc 1978, University of Copenhagen (Denmark)

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Eliezer, David (Biochemistry and Structural Biology) Assistant Professor. PhD 1994, Stanford University

Elkon, Keith B. (Immunology and Microbial Pathogenesis) Professor. MD 1974, University of the Witwatersrand Medical School (South Africa)

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Hempstead, Barbara L. (Neuroscience; Physiology, Biophysics and Systems Biology) Professor. BA 1976, Tufts University; MD, PhD 1982, Washington University School of Medicine

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Jiang, Xuejun (Cell Biology and Genetics) Assistant Professor. BS 1990, MS 1993, Fudan University (China); PhD 1999, University of Texas Southwestern Medical Center

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Kraus, William Lee (Pharmacology) Adjunct Assistant Professor. BS 1989, Cornell University; MS 1991, PhD 1994, University of Illinois, Urbana-Champaign

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Lacy, Elizabeth (Molecular Biology) Professor. BA 1974, University of Pennsylvania; PhD 1980, California Institute of Technology

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Lam, Amy (Biochemistry and Structural Biology) Assistant Professor. BA 1987, University of California at San Diego; PhD 1997, University of California at Los Angeles

Leibler, Stanislas (Physiology, Biophysics and Systems Biology) Professor. BA 1978, University of Warsaw; MS 1979, PhD 1984, University of Paris

Levi, Roberto (Pharmacology) Professor. MD 1960, University of Florence (Italy)

Levin, Lonny R. (Pharmacology; Neuroscience) Associate Professor. BS 1983, Cornell University; PhD 1989, State University of New York at Stony Brook

Li, Chenjian (Neuroscience) Assistant Professor. BS 1987, Beijing University; MA 1988, Peking Union Medical College; PhD 1997, Purdue University

Li, Gloria C. (Physiology, Biophysics and Systems Biology) Professor. BS 1963, National Taiwan University (Republic of China); MS 1966, University of Houston; PhD 1971, Stanford University

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Lu, Min (Biochemistry and Structural Biology) Associate Professor. BS 1982, Nanjing Medical College (China); MS 1985, PhD 1990, New York University

Lu, Theresa (Immunology and Microbial Pathogenesis). Assistant Professor. BS 1988; MD, PhD 1995 Yale University

Lue, Neal F. (Molecular Biology) Associate Professor. BS 1986, Johns Hopkins University; MD, PhD 1982, Stanford University

Lyden, David C. (Cell Biology and Genetics) Assistant Professor. BS 1981, University of Connecticut; PhD 1985, University of Vermont; MD 1989, Brown University

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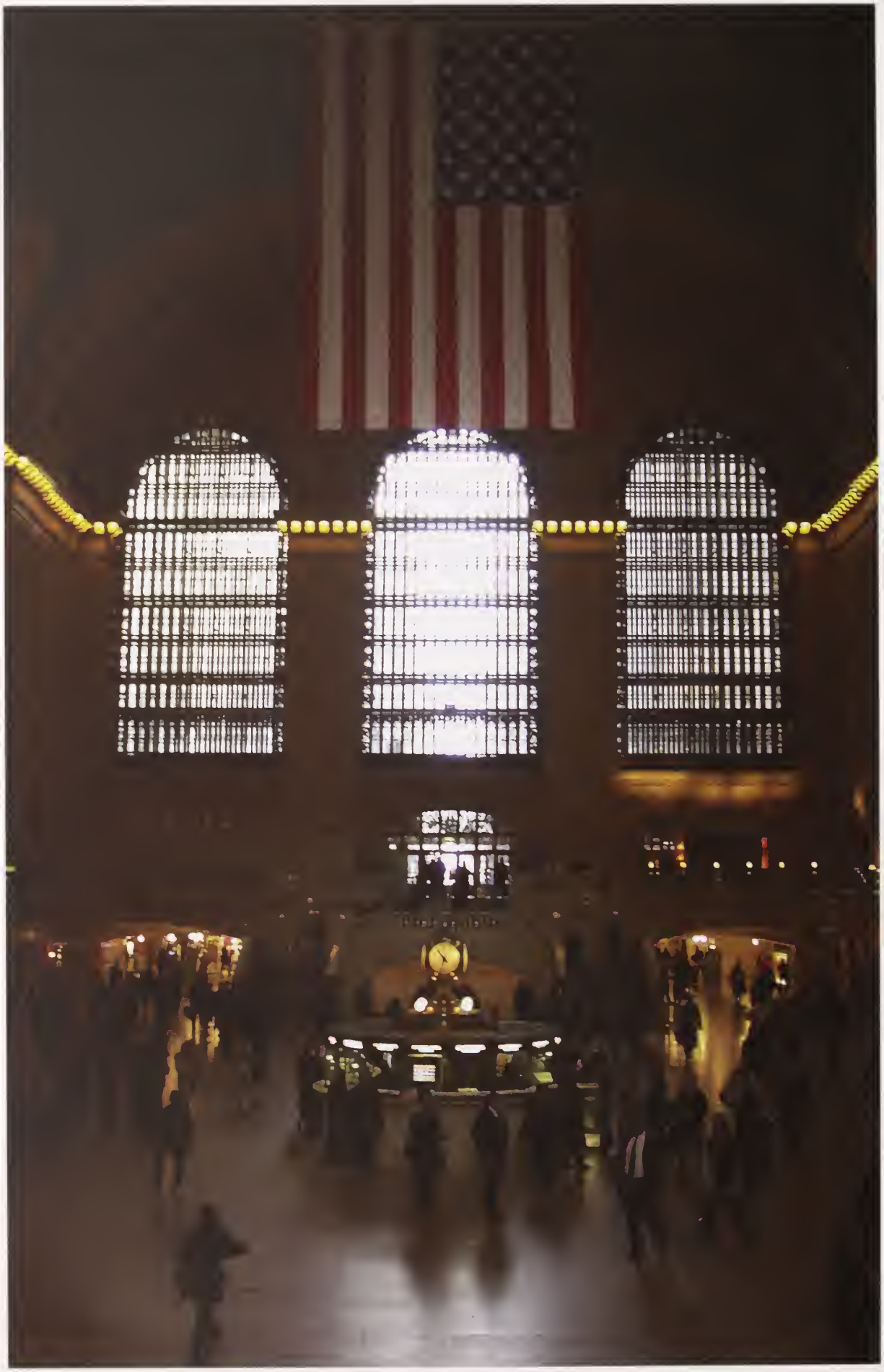

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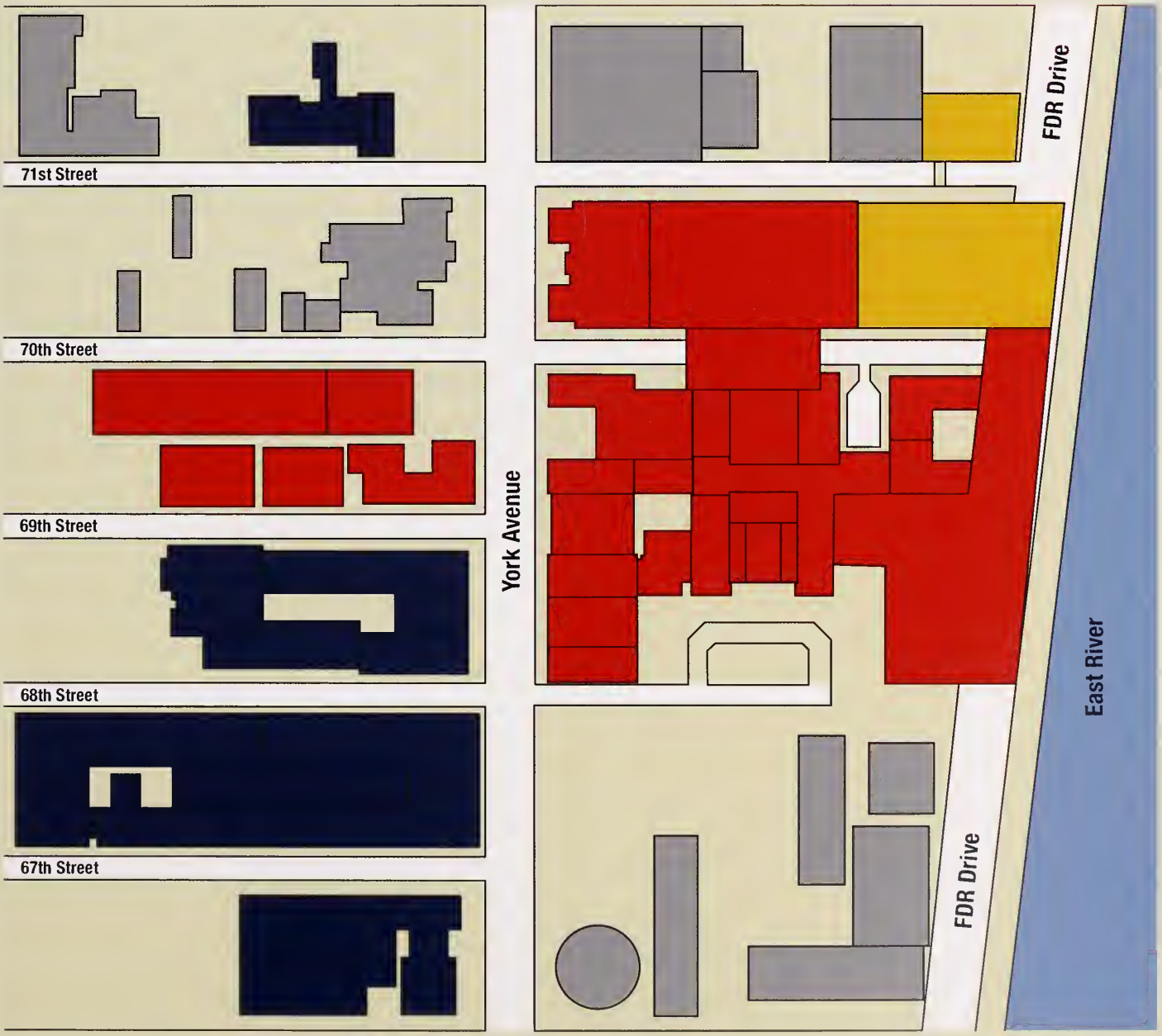

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